The Blessed Tree

Volume No. 1, Issue No. 04, December 2009, KHALIFA INTERNATIONAL DATE PALM AWARD

ZUHAIR ABU AL ADEEB

AND HALF A CENTURY OF DILIGENT GIVING

THE AWARD CAME IN THE RIGHT TIME TO EXPRESS THE SPECIAL ATTENTION AND PRIORITY GIVEN BY KHALIFA TO DATE PALM

DATE PALM .. LIFE AND CIVILIZATION

They said about
THE DATE PALM

Due to the importance of date palm in our public life and its standing in your private life. Writers, researchers, producers, growers and date palm lovers across the world are invited to provide us with your feedback and inputs about date palm. In other words, what can you say about date palm or its products in very simple and expressive words not to exceed five lines only whether in Arabic or English languages. Also you can compose poems in classical Arabic or in "Nabati" slang language.

The purpose is to open a new page (in the coming issues) from your magazine "the Blesses Tree" under the title (They Said About the Date Palm), and we will pick out and publish the most elegant phrases, ideas, words or verses of poetry received from you on date palm about all aspects, along with name of the writer and his email address.

Many thanks for your cooperation with the Award and the Blessed Tree. We will be waiting for valuable insights and participations in the love of the date palm and its products.

Materials are to be emailed to *nakhla@kidpa.ae*

جـائـزة خـلـيـفـة الـدولـيـة لـنـخـيـل الـتـمـر
KHALIFA INTERNATIONAL DATE PALM AWARD

OUR TREE

Under the wise leadership of Khalifa ... UAE continue its march of grand achievements

On December 2, 2009, UAE celebrates the 38th Anniversary of its National Day and the strong union pillars have been established and settled and UAE model became – thanks to Allah – a prominent mark for the advancement of countries and nations due to the wise policies and the great achievements and what UAE enjoys of safety, security, stability, prosperity and peace under the wise leadership of His Highness Sheikh Khalifa Bin Zayed Al Nahyan, UAE President.

Since His Highness stressed in his speech on the first of December 2004, that "what our nation enjoys today from well-established position, dignity, peace and prosperity is the fruit of a long march of vigorously efforts, persistence, and hard work led by the late father Sheikh Zayed Bin Sultan Al Nahyan (God Rest His Soul in Peace) with wisdom and patience". He put all the country's wealth and did his best to build the nation and ensure its advancement and provide a life of dignity to the citizens and residents in the country until reaching what we have now.

The late father Sheikh Zayed Bin Sultan Al Nahyan, the founder of UAE and builder of its modern renaissance, has won love of the nation and unanimous loyalty and people were proud of the country wise leadership and his efforts to serve the nation and the citizen since he was appointed a ruler of Al Ain and the Eastern Region in 1946 till taking the reign in the Emirate of Abu Dhabi in 1966 until being elected as president of the country after the declaration of the federation of UAE on December 2nd, 1971.

After his demise the nation vowed to continue the work and follow his path to attain all achievements that he accomplished and build on these achievements as HH Sheikh Khalifa Bin Zayed Al Nahyan confirmed on November 21, 2005 by saying that (the leadership of UAE, government and people insist to carry on and follow the path laid by our late father Sheikh Zayed Bin Sultan Al Nahyan and shall continue to be loyal to his values, morals and principles and all what he attained from achievements at all levels).

On this important and dearest occasion (UAE National Day), we would like to extend our warmest greetings and congratulations to HH Sheikh Khalifa Bin Zayed Al Nahyan, UAE President and to HH Sheikh Mohamed Bin Rashid Al Maktoum, Vice President, Prime Minister and Ruler of Dubai and to HH Sheikh Mohamed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi, Deputy Supreme Commander of UAE Armed Forces, and to the people of UAE and to those who reside in UAE and wish all of them Many Happy Returns.

Nahayan Mabarak Al Nahayan
Minister of Higher Education and Scientific Research
Chairman of Khalifa International Date Palm Award Board of Trustees

جـائـزة خـلـيـفـة الـدولـيـة لـنـخـيـل الـتـمـر
KHALIFA INTERNATIONAL DATE PALM AWARD

OUR MESSAGE

Sustainable Date Palm Production

With the first go ahead of the Fourth International Date Palm Conference to be hosted by Abu Dhabi during the period from March 15-17, 2010, work teams and technical committees started their work tirelessly and actively according to a prescribed agenda and a clear vision with the directives of His Highness Sheikh Nahayan Mabarak Al Nahayan, Minister of Higher Education and Scientific Research, President of Board of Trustees of Khalifa International Date Palm Award. This conference which became one of the pillars of scientific development related to date palm cultivation and production of dates at the Arab and international levels. It attracted many researchers and specialists involved in date palm from around the world, and with the mounting of nutritional knowledge of the people and the high nutritional value of dates and the trend to the safe organic products away from the modified genetic food or which has a high residual rate of pesticides and chemical fertilizers and its negative impact on general health and environment alike. The global demand of dates started to rise increasingly.

From this point, it came imperative that this industry (Date palm cultivation and production of dates) should take a new dimension in the national development process to keep its consistency. Development have to be sustainable according to UNDP recommendations for environment, conferences, international decisions which are abiding in many times to preserve for mankind and his society his natural resources for a better future.

Sustainable development means – in the language of science and knowledge – to meet the present needs without compromising the ability of coming generations to fulfill their needs, from this the motto of the Fourth International Date Palm Conference came under the title (New Dimensions and Challenges for Sustainable Date Palm Production) which means the ability to keep pace of this industry to the entitlements of the sustainable development according to decisions of the international committee for environment and development known as the report on our joint future. This report contributed in its focus on the concept of sustainable development and the rise in the environmental awareness to individuals in the society and preserving its natural resources.

From this point we would like to re-invite all researchers, specialists, those interested and date palm passionate across the globe to participate with their scientific papers in this conference and we extend a worm welcome for them in the UAE for a sustainable society.

Dr. Abdelouahhab Zaid
Secretary General of Khalifa International Date Palm Award
Editor in Chief.

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KHALIFA INTERNATIONAL DATE PALM AWARD

The Blessed Tree

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Design, Layout and Printing
Fine Line
ADVERTISING & PUBLISHING L.L.C
P.O Box 111047, Abu Dhabi, U A E
Tel. 0097126333970
Fax: 0097126333756
Finelinead@hotmail.com
finelinead@emirates.net.ae

Publication criteria in the magazine

1. The articles should be new, dedicated particularly to the Award's magazine, and have not published before.
2. Articles are to be in a soft copy, whether in Arabic or English, and should be supported by specialized sources and references at the end.
3. Researches and studies should be accompanied by the required scientific photographs of high quality (digital / high resolution).
4. Articles and photographs are to be submitted to the magazine by e-mail, or to be sent to the Award's P.O. Box on a CD with a typed and printed hard copy.
5. The magazine is not obliged to return the articles back, whether published or not, to the participants.
6. A writer of an article should enclose a personal photo with his CV including the full name, phone number, email and P.O. Box, in addition to the bank account number in English (Name, Name of the Bank, Account Number and Swift Code) in order to allow sending him the due amount in case the article is published, in compliance with the Magazine's financial system.
7. All Articles in the magazine necessarily reflect the views of their respective authors and do not oblige Khalifa International Date Palm Award.
8. Scientific subjects in the magazine are arranged according to technical considerations.
9. The Magazine welcomes readers from all the date palm lovers around the world, who contribute in deepening the knowledge and building a sustainable society.

Scientific Supervision Board

Magazine Correspondences
All technical and scientific materials are to be addressed to the Head of the Media Committee, Editorial Manager, on the following address:
P.O. Box 42781, Abu Dhabi, UAE
Mobile No. 0097150 6979645
Fax: 0097126391584
0097137832550
emadsaad_26@yahoo.com
nakhla@kidpa.ae
www.kidpa.ae

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Khalifa International Date Palm Award General Secretariat published

The Annual Book to document the achievements of the Award in its First Session 2009

Khalifa International Date Palm Award General Secretariat published the first Annual Book in order to document all activities and events achieved by the Award in its First Session 2009 at al levels and areas. Starting from the Presidential Decree issued by His Highness Sheikh Khalifa Bin Zayed Al Nahyan, UAE President concerning the establishment of the Award until the other ministerial decrees issued by H.H. Sheikh Nahayan Mabarak Al Nahayan, Minister of Higher Education & Scientific Research, Chairman of the Board of Trustees of Khalifa International Date Palm Award in addition to the different activities the Award participated in. Moreover the meetings of Board of Trustees and the outcome decisions and the results of the works of the first session for the Award applicants, arbitration results of the scientific jury. The book concludes its pages with the honouring ceremony which took place on March 15, 2009 for winners and honoured figures by H.H. Sheikh Nahayan Mabarak Al Nahayan, Minister of Higher Education & Scientific Research, Chairman of the Board of Trustees of Khalifa International Date Palm Award. The book came as a fruit of the good efforts made by the Media Committee under the keen supervision of H.E. the Award Secretary General. The book was issued in a fancy edition (Hardcover) by the approval of the National Media Committee No (1/100122/24350) and the ISBN of the book is (978-9948-15-336-8) by the National Media Committee.

The Blessed Tree

Got an Official License and ISBN

With all thanks and appreciation, the Media Committee at Khalifa International Date Palm Award received the licensing letter from the National Media Council with Ref. No (3995) dated 09/07/2009 of "the Blessed Tree" Magazine as a quarterly scientific magazine specialized in date palm.

In addition to that the magazine has obtained its ISBN from Ministry of Culture, Youth and Community Development in the capacity of the official body to grant the ISBN in UAE and the magazine ISBN is (978-9948-15-335-1). Thus the Blessed Tree has positioned itself officially among scientific magazines specialized in date palm at the national, regional and international levels. This puts us in front of more responsibility and commitment to achieve the Award objectives in localization of knowledge and dissemination of science specialized in date palm cultivation and dates manufacturing and processing among the category of researchers, interested people and those who are passionate about date palm to build a sustainable society all over the world.

Organized by Date Palm Friends Society in collaboration with the Department of Culture and Information in Sharjah

People in Dibba Al-Housn are obsessed with the life tree

For a day long date palm growers and lovers in Dibba Al Hisn city situated at the east cost of UAE interacted with more than 14 specialized organizations in date palm cultivations and dates processing at the national level. They presented their expertise, know-how, scientific and guiding publications specialized in date palm trees and dates when they participated in the specialized and typical exhibition titled (Life Tree) organized by Date Palm Friends Society in collaboration with the Cultural Activity Department in Dibba Al Hisn of the Department of Culture and Information in the Eastern Region (Emirate of Sharjah) in the auditorium of Dibba Al Hisn Chamber of Commerce and Industry.

This came during the exhibition inaugurated by H.E. Abdullah Al Owis, Director General of the Department of Culture and Information in Sharjah in the presence of Abdullah Yaroof, Director of Emiri Court in Dibba Al Hisn and Tamim Al Riyami Chairman of the Municipal Council in Dibba Al Hisn and lieutenant colonel Ahmed Jumaa Head of Dibba Al Hisn Police Station and Hisham Al Mazloum Director of Arts Department in Sharjah.

The exhibition boasted various sections participations and achievements for some factories, societies and government bodies, namely: Date Palm Friends Society, Khalifa International Date Palm Award, UAEU Date Palm Research and Development Programme, UAEU Food Services Department, Food Department in the Eastern Medical Region, Al Nakheel Foundation for Heritage Works, Abu Dhabi Food Control Authority – Abu Dhabi Agriculture Department, Al Fujairah Municipality, Fujairah Heritage Village, Dibba Al Hisn Society for Arts and Folklore Heritage, Al Rajhi for Tissue Culture Plants, Dibba Al Hisn Municipality, Emirates Bio Fertilizer Factory, Alfoah Company for Developing Date Palm Sector.

It is worthy to note that Khalifa International Date Palm Award attracted the attention of officials during the inauguration and the exhibition visitors, where the opportunity was conducive to know about the Award objectives, and how to apply for its different categories and they showed an interest to get in touch and contact and activate the participation due to the importance for the date palm tree in Dibba Al Hisn and the Eastern Coast of UAE.





KHALIFA INTERNATIONAL DATE PALM AWARD




شكر وتقدير

DVD of Honoring Ceremony for winners of the Award in its First Session 2009

Khalifa International Date Palm Award General Secretariat has recently issued the first DVD which contains a full shooting of the honoring ceremony for winners of the Award in its first session under the patronage of H.H. Sheikh Nahayan Mabarak Al Nahayan, Minister of Higher Education and Chairman of Board of Trustees of the Award in the presence of dignitaries from Sheikhs, their Highnesses and Excellencies and distinguished scientists, researchers, specialists involved in date palm inside and outside UAE. In addition to the honored winners of each category in the Award every one as per his specialization.

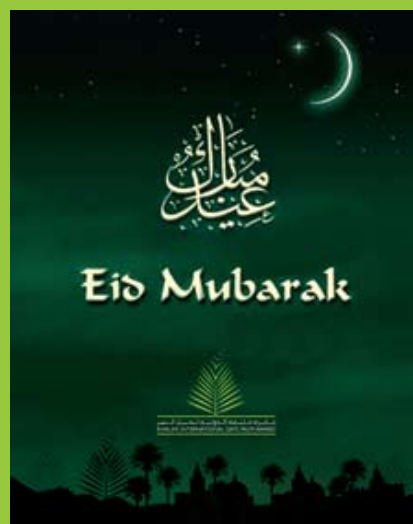
The capital Abu Dhabi has witnessed the ceremony and guests of the Award at Emirates Palace which canvassed the activities of the honoring ceremony on Sunday March 15, 2009.

For more information and to have a copy from the DVD, it can be downloaded from the following link at the official homepage of the Award on the web:

www.kidpa.ae

Eid Mubarak 2009

On the occasion of the Eid Al Adha this year, the General Secretariat of Khalifa International Date Palm Award extended greetings to their Highnesses the Sheikhs and their Excellencies the Ministries and their Excellencies members of the Board of Trustees and members of the Scientific Committee in addition to their Excellencies professors, researchers,specialists,organizations and relevant bodies with date palm tree inside and outside the country for the Eid Al Adha and wishing many happy returns, love and peace for all people.



Al Qassim Municipality circulates (hygiene containers) for dates packing

Buridah: Melfi Al Harbi:

Al Qassim Region Municipality circulated to all regions municipalities to approve the new mechanism for packing dates which is set for implementation starting from this season of the year 1430H. The new mechanism includes cancelling the previous method to pack the dates in containers (AlToul) as a final decision, and approve the modern method and the alternative way which is a unified size container (33 X 22 X 7) made from transparent white plastic or cork or wood. That came after – as per the municipality – the studies conducted by Al Qassim region date palm producer society proved the non-suitability of the previous method as the containers were manufactured from bad quality plastic materials resulted from recycling process and the change in the new method will contribute also in the process of product arrangement positively and the easy transfer in a proper way and gives the opportunity to the customer as well to check the product as it should be before finishing.

Source: Riyadh Newspaper 03/08/2009.

With the closing date of nomination for Khalifa International Date Palm Award in its Second Session

Nahayan Mabarak reviewed results of the nominations and applauded the efforts

An increase of 70% in nominations at the Second Session

HH Sheikh Nahayan Mabarak Al Nahayan, Minister of Higher Education and Scientific Research, Chairman of the Board of Trustees of Khalifa International Date Palm Award has reviewed yesterday the outcome of nominations of the Award and applauded the efforts and maneuvers put into that which reflect the great confidence achieved by the Award in its Second Session and its distinguished presence at the different scientific and production circles at the national, regional and international levels. That was achieved with the wise leadership of HH Sheikh Khalifa bin Zayed Al Nahyan, UAE President and the support of HH Sheikh Mohamed bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of UAE Armed Forces.

H.E. Dr. Abdelouahhab Zaid, the General Secretary of Khalifa International Date Palm Award pointed out that with the end of the closing of nominations for the Award in its Second Session the number of applicants reached 66 representing 24 countries from all over the world with a remarkable increase of 70% in the number of nominees distributed to five categories Distinguished Research / Studies, Distinguished Producers, The Best New Technique, The Best Development Project, Distinguished Figure.

H.E. Dr. Zaid expressed his content of the remarkable increase of the number of applicants in the different categories where Distinguished Research / Studies has recorded the highest participation percentage and at the countries level. The General Secretariat has received many participations from across the world namely; USA, France, UK, Australia, Italy, India, Iran and Japan. In addition to Iraq, KSA, Egypt, Syria, Algeria, Jordan, Tunisia, Sudan, Palestine, Qatar, Morocco, Libya, Somalia, Oman, Lebanon and UAE.

While the Arab countries have achieved the highest participation percentage worldwide where 15 Arab countries participated against 9 country from across the world which means 63% of Arab countries and 37% from the rest of the world. Dr. Zaid referred that the office of the general secretariat has started its works by sorting out and evaluating the participating works with a process enjoyed a high transparency and complete impartiality since the inception of the Award.

The SG stressed at the end of his speech at the objectives of the Award that it aspires to achieve and the most prominent the leadership role of UAE globally to develop and grow the scientific research of date palm and encourage those involved in the sector of date palm cultivation from researchers, growers, producers, exporters, organizations, societies and specialist bodies moreover honoring the distinguished figures in the field of date palm at the national, regional and international levels.

نهيان بن مبارك يطلع على حصيلة الترشيحات ويبارك الجهود

٧٠ ٪ نسبة الزيادة في عدد المتقدمين للدورة الثانية

تنظيم

70٪ نسبة زيادة المشاركين في جائزة خليفة الدولية لنخيل التمر

Isa Cultural Center
Al Manama - Bahrain

Under the patronage of His Royal Highness Prime Minister of Kingdom of Bahrain

Date Palm .. Life and Civilization

Prime Minister gives his directives to support growers and invest in the blessed tree products

His Royal Highness Prince Khalifa Bin Salman Al Khalifa, Prime Minister called the private sector to invest in the products of date palm and on top of them the ripe and dried dates and to work on enhancing and development of the Bahraini product derived from date palm saying that there is a conducive environment for this type of investment and the field is open and the government is willing to give support and encouragement. HRH the Prime Minister the local funds in particular and the Arab funds in general to participate in the increase of the food production rates and its quality until achieving self-sufficiency. HRH also called to rethink of the date palm as a symbol of life and giving which was and still has an important part in the daily food of the people of the region and an economical resource for a substantial category in the society. HRH referred that date palm was playing a critical pillar in the gulf economy in general and the Bahraini

Participants praised the efforts of Khalifa International Date Palm Award and UAE in support and development of date palm sector

economy in particular and a source of revenue for the national economy and a significant corner in the agricultural sector in the kingdom.

This came during the opening of symposium titled (Date Palm .. Life and Civilization) by HRH on Monday morning November 23, 2009 which is the first cultural activity of Isa Cultural Center in the capital city of Manama. HH Sheikh Abdullah Bin Khalid Al Khalifa, Chairman of the Supreme Council for Islamic Affairs, President of Board of Trustees of Isa Cultural Center where he welcomed the presence of HRH the Prime Minister to the inaugural of the cultural activities of the Isa Cultural Center. The title of the symposium is related to the region, its people where date palm is found it is accompanied by civilization, HH added. He also talked about the prestigious position of date pal which in mentioned by the Great and Almighty Allah in the Holy Quran in many places.

HH pointed out that Kingdom of Bahrain in the prosperous reign of HRH the King and with the wise leadership of the government chaired by HRH the Prime Minister is giving more attention to date palm which the Arabian Peninsula was and still considered its habitat and has a broad history in the region and the Kingdom of Bahrain.

HRH the Prime Minister toured the exhibition accompanying the symposium where HRH saw the products of date palm from ripe and dried dates and the handicraft relevant to the date palm. On this occasion HRH the Prime Minister stressed on the keen interest of the government to date palm cultivation and increase the green pastures and give care to date palm. HRH urged the bodies concerned in agricultural development to keep pace with the modern technologies in date palm cultivation and use state-of-the-art techniques and modern scientific methods to enhance the Kingdom date palm varieties and to achieve more better quality and excellence.

It is worthy to note that the symposium was accompanied by a number of activities relevant to date palm through the participation of some professional and handicraft societies in the Kingdom. Where there was a showcase for the profession of box maker, boat maker, date palm fronds sewing, baskets profession, molasses profession, paper making from date palm fronds, in addition to growers council and popular coffee and puppet show.

Emirates Palace
Abu Dhabi - UAE
March 15-17, 2010

Fourth International Date Palm Conference

New Dimensions and Challenges for Sustainable Date Palm Production

With directives from His Highness Sheikh Khalifa Bin Zayed Al Nahyan, UAE President and support of H.H. Sheikh Mohamed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of UAE Armed Forces, and pursuit of H.H. Sheikh Nahayan Mabarak Al Nahayan, Minister of Higher Education & Scientific Research and Chancellor of UAE University and Chairman of Board of Trustees of Khalifa International Date Palm Award, promptly efforts are put in place persistently to increase date palm cultivated areas in UAE and enhancing the date production in order to make better use of date palm industry and produce an agricultural leap that will change the face of the UAE desert.

Indeed, the Fourth International Date Palm Conference illustrates the special attention and priority given by His Highness to this important economic sector.

The Fourth Conference comes within a series of conferences launched by UAE University before eleven years, (where the First Conference held for the period from March 8-10, 1998, the Second for the period from March 25-27, 2001, the Third for the period from February 19-21, 2006). Date palm scientists, experts, and senior officials from around the world will be able to exchange their know-how and experiences. The Honorable Ministers of Agriculture of the GCC member states will be invited to attend the conference in order to disseminate the up-to-date knowledge and recommendations at the official level.

Conference Objectives: Provide an opportunity for updating scientific information on the different aspects of date palm production chain from Farm to Consumers. Compare the recent experiences in the United Arab Emirates with those of other date growing countries. Foster international technical cooperation on different aspects of date palm production chain.

Conference Theme: the Theme of the Fourth Conference is "New Dimensions and Challenges for Sustainable Date Palm Production".

Conference Special Features: among features and activities that makes the

conference attractive and renewable are as follows:

1- Internationally renowned speakers of the highest caliber,
2- Wide range of scientific subjects related to all aspects of date Palm Production,
3- Scientific input from many countries of the world,
4- Innovative approach to scientific sessions,
5- Well-Organized exhibition,
6- Tours visiting various sites of technical or tourist interest around United Arab Emirates.

Proposed Duration & Venue: Period from Monday March 15 through Wednesday March 17, 2010.

Venue: Emirates Palace in the Capital Abu Dhabi.

Content: the Conference content will include the following features:

1- Current Status of Date Palm Cultivation in the World,
2- Molecular and genetic engineering,
3- Date Palm Genetic Bank,
4- Propagation by using Tissue Culture methods,
5- Agricultural Practices,
6- Pests and Diseases Management,
7- Post Harvest and Processing Technologies,
8- Nutrition
9- Economics and Marketing,

N.B: Several round tables and brainstorming meetings will be organized.

Who Should Attend: The Fourth International Date Palm Conference is open to all people interested in date palm industries. The conference provides a forum for updating on current issue importance to this industry as well as information on new products and services. Participants will be from the public and private sectors who deal with the aspects of the date palm from producer through consumers. Examples of the participants are:

1- Date Palm Growers
2- Executive Management of Grower Organizations
3- Market Managers and International Traders
4- Scientists of all aspects of Dates and Date Palm Cultivation
5- Government Agencies and Departments
6- Specialized Research and Development Centers
7- Processors and Agro-industrialists
8- Suppliers of Packages, Transport Operators, Chemicals, Fertilizers, Planting Material, Farm Equipment and Requisites
9- Nutrition Specialists
10- Biotechnologists, Regulators and Consumers.

Booths: the following Booths shall be organized during the convening of the conference:

Date Palm photo gallery with pictures and photos of the organized International competition.

Conference High Committee:

Dr. Abdulla Al-Khanbashi, Vice Chancellor of UAEU, Conference' Chair.

Prof. Ghaleb Ali Alhadrami, Dean College of Food and Agriculture (UAEU). Chair Scientific Committee.

Prof. Abdelouahhab Zaid, Chief Technical Advisor, Director, UNDP-UAE University, Chair, Organizing Committee.

Language of the Conference: Arabic and English.

Post Conference Tours: The Organizing Committee shall arrange for the participation post conference tours free of charge on a voluntary basis and will take a full day (Thursday 18 March, 2010), those conference's guests who interested should register during the days of the conference:

1. The Emirates Date Factory - Al Saad
2. Al Ain Date Oasis
3. UAE University and Date Palm Tissue Culture Laboratory

Paper Abstracts: We will provide a booklet of the abstracts on the first day of the conference. Please submit an abstract for both oral and poster presentations (one abstract per paper or presentation) to the Conference Organizing Committee (at email address): zaid@uaeu.ac.ae in Arabic and English languages on a date no later than January 15, 2010.

Proceedings: A book to include all proceedings of the conference (full papers) will also be published after the conference. Only selected and peer reviewed paper will be published. All presenters are requested to submit their paper camera ready 3 hardcopies and digital copy, (CD, preferably in Microsoft Word) at the same deadline as the abstracts (on a date no later than January 15, 2010) to Dr. A. Zaid; zaid@uaeu.ac.ae.

For more information:

Prof. Abdelouahhab Zaid
Chief Technical Advisor / UNDP Director,
Date Palm Research & Development Programme – UAE University
P.O.Box. 81908, Al Ain, UAE.
Tel.: +971 3 78 32 334
Fax: +971 3 78 32 472
E-mail: zaid@uaeu.ac.ae

Prof. Ghaleb Ali Alhadrami
Dean, College of Food and Agriculture,
UAE University,
P.O.Box.17555, Al Ain, UAE.
Tel.: +971 3 76 35 647
Fax: +971 3 76 32 384
E-mail: hadrami@uaeu.ac.ae

Personality of the issue

The Award came in the right time to express the special attention and priority given by Khalifa to date palm

Zuhair Abu Al Adeeb And half a century of diligent giving

Be generous to the date palm with organic fertilizers, irrigation and cleanness because it is more generous than us in giving

He started his journey more than half a century ago with elders and dignitaries in Abu Dhabi. First, he came to work in education with the first education missions which were brought by HH Sheikh Hamdan Bin Mohamed Al Nahyan (May God Rest His Soul) who was sent by the then Ruler of Abu Dhabi Sheikh Shakhbout Bin Sultan Al Nahyan (May God Rest His Soul). He worked in education as a teacher for the word and letter which he engraved them in the minds of children of this nation from the leading generation who had the opportunity to keep pace to the commencement of the formal education in UAE. He started his journey at the beginning of the sixties when he joined the education field in the first school which was opened by him and three of his colleagues in 1960 in Al Ain City under the name of (Al Ain School in Buraimi).

Then he moved from teaching to another advanced responsible position to become the Agricultural Advisor of H.H. Sheikh Khalifa Bin Zayed Al Nahyan, when he was the Crown Prince of Abu Dhabi. He is still on his path of giving and loyalty with a promise and commitment to Abu Dhabi and UAE for a better future for us and the generations to come. He is H.E. Advisor Zuhair Abu Al Adeeb, the Agricultural Advisor for His Highness Sheikh Khalifa Bin Zayed Al Nahyan, UAE President.

It is our pleasure to have this exclusive interview for readers of the "Blessed Tree" Magazine on the occasion of the 38th Anniversary of UAE National Day, may we celebrate it and many more to come with joyous celebrations and our best wishes for the government and the people of UAE.

He started his speech with the following information: Before 38 years, the number of date palm trees in UAE was about 1 million and now this number may exceed 40 million date palms. This of course can only be traced back to the interest of date palm which was clear and evident by the founder and the builder of the Agricultural renaissance, the late Sheikh Zayed Bin Sultan Al Nahyan (May God Rest His Soul) and his sons who followed their father's path.

His Highness the President gives special attention and priority for date palm, as well as H.H. Sheikh Mohamed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of UAE Armed Forces, where they put all their efforts in order to improve the current situation of date palm and dates in the country to meet local needs and provide a surplus for export.

What does a date palm mean to you?

A date palm means a lot for every Arab and every Muslim, as it was mentioned in the Holy Quran in more than 20 verses. It is a blessed tree, grown in a dry desert environment and provided the people of this region with its fruit which was enough for them (as a nutrition) from other food types except for camel milk

which constitutes with it a full meal that provide the body with its nutritional needs and gives it the immunity and protects it from diseases.

Statistics of World Health Organization and Food and Agricultural Organization of the United Nations, point out that a Bedouin man is in less danger to contract cancer diseases from others who live in the city because he depends on dates in his nutritional system. Dates contain a high percentage of magnesium and anti-oxidants which protect the body from cancer.

Since when did you start to be interested in Agriculture in general and date palm in particular?

My interest in Agriculture in general started form my early childhood where I was born in an agricultural area called Houran, south of Syria. It is an ideal agricultural area, famous of its corps from wheat, barley and chickpea and others. Then I moved to Jordan where the natural extension of the Arab tribal history in the region of Asalt mountain which is known for vegetables and fruits plantations. Finally, it was my third and last stop in November 1960 in Al Ain city. Date palm was the first thing my eyes caught, oases were full of date palm trees which is the main token of Al Ain city. My agricultural journey began with H.H. Sheikh Khalifa Bin Zayed Al Nahyan, UAE President. HH was very keen to grow the best quality varieties brought from across the world, until UAE became among the most important agricultural areas which have the highest number of date palm trees in the world (according to the statistics of Ministry of Agriculture). This achievement has been attained thanks to the unlimited support for the blessed tree (date palm) by the late father Sheikh Zayed Bin Sultan Al Nahyan (May God Rest His Soul) and his devoted sons.

What are your main stops and achievements that you presented to the Blessed Tree?

At the start of my journey and during the seventies of the last century, we established date palm farms depending on local varieties and following the traditional agricultural methods including the irrigation method of canals.

In the eighties we introduced the modern irrigation systems with their different patterns that are distinguished with their high quality in saving water, limit the growth of harmful weed plants and enhancing growing of date palm and produce high quality dates.

Also on the part of development aspects that I approved, introducing new varieties which are world class and high in characteristics through importing them from Arabian Gulf countries, Iraq, Iran, Pakistan, Western Arab countries and even from California. During these days date varieties were very few and can be counted on the fingers of our hands, but nowadays I can estimate the number of varieties more than one hundred and the most significant thing about these varieties that they are good for eating and storage.

I established modern farms for HH the President, which are considered the best farms because they apply state-of-the-art agricultural technologies existing in the date palm fields, including farms of male date palm from the world best quality as they have direct impact on the characteristics of the fruits (dates) and their improvement.

Whilst we found that the quantity of dates has doubled several times in subsequent years, we decided to set up dates processing plant after being sterilized, washed, manufactured and stored in special coldrooms. That was back in 1986 when we were in a special visit with His Highness in the State of California, as there was some inner towns which have date palm trees, we found that every grower who has about 4,000 date palms has his own factory. At that time, we got more than 20,000 date palms, therefore I sat up the first factory in the region and it is still running with full capacity and with highest qualities. Noting that all produced dates by Al Ain Dates Factory are from the farms of H.H. Sheikh Khalifa Bin Zayed Al Nahyan, UAE President, and are consumed and distributed as personal gifts from His Highness to relatives, friends, Arab Kings and Presidents, foreign friends and guests.

How do you see Khalifa International Date Palm Award

The Award in itself is an honor for all of us in UAE, it is an honor for all and wish to achieve its objectives in development of date palm across the world. Through keeping up my work with H.H. Sheikh Khalifa, I can safely say the Award came in the appropriate time and it is an extension of education and knowledge that continued from Zayed to Khalifa to his Crown Prince in promoting and supporting date palm and production of dates in the country.

How do you estimate the current situation of date palm cultivation and dates processing in UAE?

Date palm cultivation and dates production in UAE is characterized by keeping pace with development and uses technical advancements in all agricultural and post harvest processes which contributed to place UAE in advanced positions among world countries concerned about date palm and dates.

However, there are some constrains in regard to marketing processes which adversely affect growers' interests in service of their farms and dates production and this issue needs to be necessary addressed in an appropriate manner.

What's your vision to develop the situation of date palm in UAE?

It is well known in date palm cultivation in order to get best and promising quality varieties with desired specifications whether female or male, we resort to seeds planting (nuclei) but this method results in 50% males and 50% females and often with poor quality characteristics, nevertheless there may be date palms with desired specs among the off-shoots and for both genders. We obtained 350 male date palm trees with active pollen ranging from (97-99%) from a number of 15,000 seedlings which were planted by seeds.

Further to that, we obtained promising (female) date palm trees from seeds of well-known varieties (Sak'ie – Bahree – Khalas – Mejhoul …).

From the prominent achievements in this field that we produced a male date palm tree with distinguished specifications, we called it "male of Al Ain City". About this subject, "I was assigned by H.H. Sheikh Khalifa in 1978 to travel to the South of Tunisia (Tozeur City) to buy 2,000 off-shoots from a variety called (Deglet Al-Nour) and after many years and by chance and continued follow-up for this variety (which did not succeed in UAE except as a green plant without good fruiting), we obtained a male date palm which produced an extra-ordinary pollen with the best quality and this date palm still exists in the palace of the President in Al Ain" Zuhair Abu Al Adeeb said.

We tried all techniques and methods to propagate it but we did not succeed until we used the tissue culture technique in Date Palm Tissue Culture Laboratory (DPTCL) at Date Palm Research and Development Programme in United Arab Emirates University, when the DPTCL team under the supervision of Prof. Abdelouahhab Zaid, managed to propagate this male date palm in large quantities, we would have not been able to solve this problem without the help of science.

Now, I am doing an experiment on variety " Deglet Nour" as well, since I planted it at the foot of Hafeet Mountain at 900m above sea level, and I am waiting to see the results in the coming season God willing. It is also worthy to note that in this field I planted the variety Ajwat Al Madinah Al Munawarah in a rocky environment at top of Hafeet Mountain in Al Ain since 6 years and surprisingly it gave impressive results that exceeded doubling the fruit of the original variety Ajwat Al Madinah Al Munawarah.

What do you advise coming generations?

Date palm cultivation in UAE is one of the most important traditions that the country is famous of and leads all world in love of the date palm from Zayed to Khalifa to Mohamed to all the citizens of our homeland, they planted love of date palm in the hearts of UAE nationals before they plant it in the land. This way started to bear its fruits and the testament on that seeing date palms in the streets, farms, public parks, main roads and almost all homes of citizens have date palm in them.

Wherever you look in UAE land you will see date palm tree stands high with the spirit of its children and ornaments its land and sky, where the plenty of date palm trees is one of the major token and landmarks of Abu Dhabi and Al Ain.

On this occasion, I would like to give my children and brothers from date palm lovers a piece of advice to choose the varieties which will benefit them financially and nutritionally and they have to be generous to the date palm with organic fertilizers, irrigation and cleanness because it is more generous than us in giving.

Azhari O. Abdelbagi
Crop Protection Dep. Faculty of Agric.,
University of Khartoum
mahdiaa2003@yahoo.com

Hamadttu A. Elshafie
Mahdi Abdel Elrhman Ahmed
Dongola Reseach Station
ARTC, Sudan

Trunk injection with neonictoniods insecticides for control of the green pit scale insect (*Palmapsis phoenicis* Ramachandra Rao) (Homoptera: Asterolecaniidae) infesting date palm in Northern Sudan

Abstract

A small scale field experiments were carried out in Elgaba scheme, and El Golid area during seasons, (2003/2004-2004/2005) to evaluate the efficacy of four systemic insecticides; imidacloprid as Confidor 200SL, Rinfidor 20%SL and Comodor 20% SL and thiamethoxam as Actara 25WG, against the green pit scale insect (Palmapsis phoenicis Ramachandra Rao). A trunk injection technique was used. The insecticide thiamethoxam as Actara 25WG was tested at 6, 8 and 10g/palm for. While imidacloprid as Confidor 200SL, Rinfidor 20% SL and Comodor 20% SL was tested 10, 15 and 20 ml/palm. The irrigation was scheduled every 10 days. The Completely Randomized Design with six replicates (one palm = replicate) was used. The insects (all developing stages) were counted (cm^2/leaflet). Eight leaflets from each palm were inspected at biweekly intervals. Dates yield and quality were determined at harvest. Residue analysis was carried out on dates, soil and intercropped plants twice (at rutab stage and harvesting).

Results indicated that the % mortality (adult and immature stages) were significantly higher in insecticides treatments than the untreated control. Results of residue analysis indicated that, no residues of both imidacloprid and thiamethoxam were detected in dates, soil and intercropped plants when treated with the high doses. The higher doses remained effective throughout the experimental period. Date palm treated with the higher doses of tested insecticides, developed normally and the dates reached maturity (ripening) and the yield was increased by more than 70%

Trunk injection(boring a hole into trunk)

Trunk injection(local equipments)

compared with the untreated control. All insecticides checked termites and many other pests, but did not affect mites. This method of application was found highly economical and safe for the users with minimal environmental impacts.

1- INTRODUCTION

Date palm (Phoenix dactylifera L.), is considered one of the most important fruit crops, and provides a primary article of food and commerce in the great desert areas of Western North Africa to India, and many other subtropical areas. The tree is drought and salt tolerant, and its tasty fruits have high nutritional value and good storage properties. Date fruits constitute the most important agricultural crop in the area and provide highly nutritious food as well as a primary source of income to the majority of the inhabitants. The date palm offers a good food source of high nutritive value (Shinwari, 1993). Furthermore, the date palm tree tolerates relatively harsh climatic and soil conditions under which no other crop may give reasonable returns. In fact, date palm which is an irreplaceable tree in irrigable desert lands, provides protection to under-crops from heat, wind and even cold weather, and plays a big role in combating desertification. Its fruits generate foreign exchange earnings. Its dried fruit bunches, fronds, leaflets fiber and trunks are utilized in many small industries as packing materials in local marketing of fruits and vegetables as well as for many other purposes. The tree and fruit by-products offer an extra income. Timber is produced from stems, while fronds are widely used for thatching, buildings, barring and basketry (household utensils). The date palm tree is cultivated in the Northern Sudan along the banks of the Nile over a distance of about 900 kilometers. The total number of trees is about 7-8 million (Osman, 2001, Baballa 2002 and Ahmed, 2005). According to FAO (2005) the, mean annual production of dates is 328.2 metric tons. This ranked Sudan as the 7th largest producer of dates among Arab countries.

However, the date palm industry is facing many serious problems, related to low yields, lack of appropriate packing and presentation as well as limited processing of date products. The estimated average yield of bearing date palm tree in the main date growing areas in Sudan is around 20 kg, which is very low compared to the average yield of more than 100 kg in other date growing areas (USA, Qassim in Saudi Arabia and Namibia,) (FAO, 2002). The low yields in most countries, including Sudan, are due to soil salinity, poor fertility, insect pests and diseases, lack of maintenance and care due to increasing cost of labour and to shortage of personnel trained in improved cultural practices. As a result of the high cost of production and low prices of the produce, farmers tend to neglect or even abandon their orchards. Although the commonly known, insect pests like red weevil and diseases like bayoud have not been reported, in Sudan, the yield of the date palm is affected by many biotic factors among which insects are the most important.

In the Sudan, the green date palm pit scale insect, Palmapsis phoenicis Ramachandra Rao (Asterolecanium phoenicis Rao.) is considered the key pest. This genus, a native of central Asia (Iran), (Ezz, 1973) was not known in Sudan before 1989 when it was firstly reported by Ali (1989) in El Golid area, as a result of an introduction of some offshoots from Saudi Arabia in 1974. Later, the pest crossed the natural barrier of Baja desert to invade Elgaba scheme, (150 km south of Dongola, 400km-north of Khartoum) and has become a real threat to date palm cultivation in Northern Sudan. The infested area in El Golid, Elgaba and Old Dongola is about 5000 hectares, extending over 60 and 50 kilometers along the west and east banks of the river Nile respectively. The newly reported infestation in Artigasha Island,

Injecting the undiluted insecticide into the trunk

Trunk injection (inserting the tube into the trunk)

Burgag scheme and Orbi in Dongola area, Abuhamad in the River Nile State (23000 infested palm trees) and Khartoum State, provides evidence that the pest may continue to spread.

The insect attacks the leaflets, leaf rachis and fruits. It causes chlorosis, degeneration of the leaves, malformation of fruits before maturity leading to losses in production from a range of 30-50 kg to 5 kg per tree (Ali and ElNasr. ,1992). The losses may range between 85 and 90% according to infestation rate, variety infested and management conditions (Ahmed ,2001 and 2004) . In the past, and due to lack of indigenous knowledge of the nature of this pest, control efforts were not successful; hence the level of infestation steadily increased.

Based on growing importance of this pest, its serious impact on date production, this study was initiated to investigate the possible control measures for the green date palm pit scale insect. Thus the main objectives of this study were:

1- To determine the efficacy of imidacloprid and thiamithoxam compounds in controlling the date palm green pit insect.

2- To evaluate the efficacy of these compounds against re infestation by this insect.

3- To study the effects of tested compounds on other insect pests of the date palm.

4- To check the residues of tested compounds in dates, soil, water and intercropped plants.

2- MATERIALS AND METHODS

2.1 Experimental sites:

A small scale experiments were carried out at Elgaba scheme and El Golid area during the seasons (2003/2004- 2004/2005) to evaluate the efficacy of four systemic insecticides (belonging to the new group of inecticides, neonictoniods) against the green date palm pit scale insect using trunk injection application techniques. Barakawi variety, the most predominant one was selected. A Completly Randomized Design with 6 replicates (one tree = replicate) was used.

The first experimental site is Elgaba scheme. A farm in the middle of the scheme was selected. The history of infestation dated about 6 years earlier and the estimated loss in date yield was more than 70% and 80% for Barakawi and Gondeilla varieties, respectively. Palm age and heights were between 15 - 20 years, 10- 15 meters, respectively. Flood method of irrigation from the Nile is conducted monthly via the scheme's main canal. Supplementary irrigation is given using diesel pump from underground water. Urea was usually added in summer for intercropping fodder crops (maize, durra and legumes). No chemical control has been conducted in the area before.

As a result of the intensive chemical control program in Elgaba scheme in April – June 2004, the experimental site, was moved to El Golid area. The locations selected was a farm three kilometers from the Nile, it was highly infested. The age of trees was between 10 and 15 years with heights ranging between 8 and 10 meters. Intercropping with fodder crops was dominant. Urea and cattle manure were applied to fodder crops. Flood method of irrigation from the Nile is conducted during the flood season. Supplementary irrigation is given using diesel pump from underground water.

The estimated loss in yield was more than 70% for Barakawi variety. Chemical control was conducted during the extensive control program in this area in 1991.

Cultural practices followed before the experiments:

The following cultural practices were usually carried out:

a. Pruning, removal of dead leaves and the lowest row of the highly infested leaves.

b. Raising earth around the palm to facilitate irrigation (every tree is irrigated individually)

c. Pre-watering (24 hours) before application (of the insecticides) using diesel pumps from underground water

2.2 Trunk Injection Technique

Holes of 15 cm deep were bored into the trunk and an open end snout metallic tube was inserted. The tube; 25 cm in length and 1.5 cm in diameter were inserted into the hole at an angle of 45° about one meter above the ground. The tube can hold at least 25 ml of the diluted insecticide (Al-Jbooryi et.al, 2001). A developed calibrated "drench mastic" injection gun (used by Fernandez and Gllego, 1997 and Filer, 1973) was not available, so a 25 ml measuring cylinder was used for this purpose. When the injection was over, the tube was closed with tight- fitting flap. Apart from gloves the user also wore a mask for face and eye safety.

The following insecticides were used at the following doses. The injection volume was made up to 25ml using tap-water

Elgaba scheme, season 2003/2004

1) Thiamethoxam as Actara 25 WG at 10 g / tree (2.5 g a.i)

2) Thiamethoxam as Actara 25 WG at 8 g / tree (2.0 g a.i.)

3) Thiamethoxam as Actara 25 WG at 6 g / tree (1.25 g a.i)

4) Imidacloprid as Confidor 200SL at 20 ml / tree (4g a.i.)

5) Imidacloprid as Confidor 200SL at 15 ml / tree (3g a.i.)

6) Imidacloprid Confidor 200SL at 10 ml / tree (2g a.i.)

7) Untreated control (by injecting with water only)

El Golid area, season 2004/2005

1) Thiamethoxam as Actara 25 WG at 2.5 g a.i / tree (10 g product)

2) Thiamethoxam as Actara 25 WG at 2.0 g a.i. / tree (8 g product)

3) Thiamethoxam as Actara 25 WG at 1.25 g a.i. / tree (6 g product)

4) Imidacloprid Confidor 200SL at 4g a.i / tree (20 ml product)

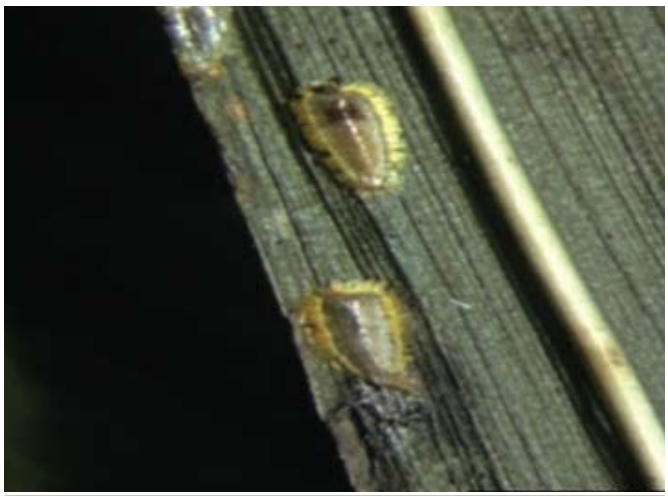
5) Imidacloprid Confidor 200SL at 3g a.i. / tree (15 ml product)

6) Imidacloprid Confidor 200SL at 2g a.i. / tree (10 ml product)

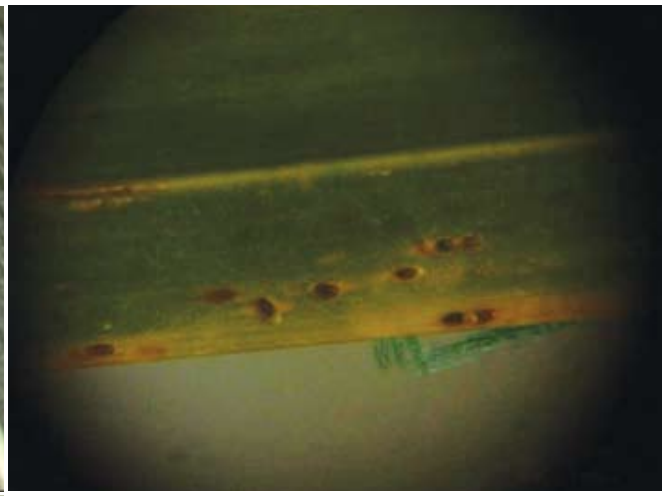
Cholorosis &Degeneration on leaflets

Highly infested offshoot

Chlorosis & malformation on Fruits



Adult females (Gassouma,2003)



Mature adult females

7) Imidacloprid Rinfidor 20%SL at 4g.a.i / tree (20 ml product)

8) Imidacloprid Rinfidor 20%SL at 3g.a.i. / tree (15ml product)

9) Imidacloprid Rinfidor 20%SL at. 2 g.a.i. / tree (10ml product)

10) Imidacloprid Comodor 20%SL at 4g.a. i. / tree (205ml product)

11) Imidacloprid Comodor 20%SL at3.a.i / tree (15ml product)

12) Imidacloprid Comodor 20%SL at 2g.a.i / tree (10ml product)

13) Untreated control (by injecting with water only)

A residue analysis was carried out on dates, soil and intercropped plants twice at harvest.

2.2.1 Insects count

Samples of eight leaflets (two leaflets from each of the four main directions) were inspected at biweekly intervals and examined under binocular microscope. The number of living and dead adult females and immature stages were recorded per three cm^2 of each leaflet (tip, top and bottom). An average per cm^2 was obtained and the following parameters were calculated:

a) Percentage mortality of adult females.

b) Percentage mortality of immature stages.

Pre-spray count was undertaken before insecticide application.

2.2.2 Yield and yield components

At harvest, triplicate samples of 50 date fruits were taken at random from each replicate, collected samples were used to assess the percentage fruit maturity (ripening).Sub-samples of ten date fruits were taken to the lab to determine the following parameters:

a) Mean fruit weight (g)

b) Mean fruit length(L) (cm):

c) Mean fruit diameter (D) (cm):

d) The L/D ratio

e) Percent seed/fruit weight.

Yield in kilogram per palm was determined at harvest. Samples of date fruits, soil and grasses were taken to ARC laboratory at Wad Medani for residue analysis.

2.3 Residue analysis of the tested compounds

2.3.1 Residues of thiamethoxam as Actara 25 % WG in Date palms.

1. Treatment and sampling:

The insecticide was applied by trunk injection at dosage rate 2.5g a.i (10g product) for soil application. The treatments were done on 15/6/2003.

Treated and control samples of date palm fruits, soil, and intercropped plants were taken in three replicates. Samples were collected early season, 25/8/2003 (unripe fruit stage) and at harvest 1/10/2003. Samples collected were brought to the laboratory; the samples were reduced by quartering and kept at –20 ºc for residue analysis.

2- Extraction and Clean- up

The method of residue analysis employed was provided by Syngenta Analytical Department (REM 179.01).

Sub-samples (10 g) each were taken in triplicate from each of the treated and replicates they include grass and date palm fruits. The material was extracted by homogenizing with 50 ml of a mixture of water / methanol (1:4 v/v) using a high- speed blender for three minutes. The homogenized material was filtered through a Buchner funnel into an Erlenmeyer flask using Celite filter aid. The filtrate was transferred into a 100 ml volumetric flask and brought to volume

with the same solvent mixture. An aliquot of 5 ml of the filtered extract was diluted with the same volume of water and cleaned-up by solid phase extraction using disposable solid- phase columns (Bond Elut C-18). Elution was done using water / tetrahydrofuran (1:4 v/v). The elutes were then concentrated to dryness and the residues were taken into the minimum amount of acetone (0.5 ml) and kept for analysis. The extraction of soil samples was done by shaking 50 g soil sample with 200 ml water/ methanol mixture (1:4 v/ v) for two hours using a horizontal shaker.

3- Analysis

Analysis was carried out by thin-layer chromatography (T L C) using ready-made silica gel GF 254 coated plates with a thickness of 0.25mm (Merck). After spotting of thiamethoxam standard and samples, the plates were developed in a system of isopropanol / toluene (1:1), and visualized under a short wave ultra violet lamp (254 nm). RF values were determined.

2.3.2 Residues of imidacloprid used as Confidor 200 SL, Renfidor 20% SL and Comodor 20% SL.

1. Treatment and sampling:

The insecticides were applied by trunk injection; the treatments were done on 10/6/2004 at dosage rates as mentioned in (2.2). Samples contain date palm fruits, intercropped plants and soil were collected from sites treated with high doses; 20ml product/tree (4g.a.i.). Samples were collected early season, 20/8/2004 (unripe fruit stage) and at harvest 1/10/2004.

2. Extraction and clean up

For analysis, sub-samples of 50g date fruits were taken randomly from treated and untreated trees and intercropped plants, and then mixed with 300ml of methanol/water mixture (3:1) and allowed to soak for 30 minutes. Then the sample was homogenized and filtered using 10g celite as filter aid. The filtered was transferred into a graduated cylinder, filled up with methanol to total of 250ml and homogenized by agitation. An aliquot (100ml) was removed. Transferred into 1000ml round-bottomed flask and concentrated to about 20ml using rotary evaporator.

Clean up was carried out using 10g Amberlite XAD 4 resin packed into a chromatography column having an inner diameter of 10mm. the column was rewetted with methanol and water. All aqueous elutes were discarded. The residues were eluted with 100ml methanol. This elute was collected and concentrated to dryness and the residues were taken into 0.5ml acetone and kept for analysis.

3. Analysis

Analysis was carried out by thin-layer chromatography (TLC); on readymade silica gel GF_{254} coated plates. After spotting of the samples and standard of imidacloprid, the plates were developed in a system of isopropanol/toluene (1:1) and visualized under short wave ultra violet lamp. (254nm).

3: RESULTS

3.2 Trunk injection method.

3.2.1 Insects count

The mean biweekly total death (adult females and immature stages/ cm^2 of leaflet) for the first season 2003 / 2004

Table (1) Mean biweekly total mortality of green pit scale insect from trees treated with different insecticides (using trunk injection method) at Elgaba scheme season 2003/2004.

Insecticide	Dosage rate per palm	Mean no. of dead scales at weeks after injection					
		0	2	4	6	8	12
Actara 25WG	10g.p (2.5g.a.i)	0.4 (0.9)	6.2 (2.6)^{AB}	9.3 (2.5)^{AB}	9.1 (2.7)^{A}	4.6 92.6)^{A}	4.7 (2.3)^{AB}
Actara 25WG	8g.p (2g.a.i.)	0.94 (1.2)	5.6 (2.5)^{AB}	4.0 (2.1)^{ABC}	5.4 (2.5)^{AB}	3.9 (2.1)^{AB}	3.8 (2.1)^{BC}
Actara 25WG	6g p (1.5g. a.i)	0.97 (1.1)	4.1 (2.1)^{BC}	2.9 (1.8)^{C}	4.4 (2.2)^{AB}	3.1 (1.9)^{AB}	1.9 (1.5)^{CD}
Confidor 200SL	20ml (4g. a.i)	1.6 (1.5)	8.8 (3.1)^{A}	6.6 (2.7)^{A}	5.9 (2.5)^{AB}	4.0 (2.1)^{AB}	6.7 (2.7)^{A}
Confidor 200SL	15ml (3g. a.i)	0.6 (1.0)	2.9 (1.9)^{BCD}	4.1 (2.1)^{ABC}	4.7 (2.3)^{AB}	1.2 (1.3)^{AB}	3.4 (2.1)^{BC}
Confidor 200SL	10ml (2g. a.i)	1.0 (1.2)	1.4 (1.0)^{D}	3.2 (1.9)^{BC}	3.2 (1.9)^{B}	3.2 (1.9)^{BC}	1.7 (1.5)^{CD}
Untreated control	water only	0.9 (1.2)	1.4 (1.3)^{D}	0.95 (1.2)^{D}	0.73 (1.1)^{C}	0.5 (1.0)^{C}	1.3 (1.3)^{D}
SE±		0.16	0.22	0.17	0.19	0.24	0.17
C.V%		23.3	18	14.4	15.04	22.0	15.5

-Data in brackets were √x+0.5.

-Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table (2) Mean biweekly percentage mortality of adult females and immature stages of green pit scale insect from trees treated with different insecticides (using trunk injection method) at Elgaba scheme season 2003/2004.

A: Adult Females		% Mortality of scales at weeks after injection					
Insecticide	Dosage rate/ palm	0	2	4	6	8	12
Actara 25WG	10g.p (2.5g.a.i)	9.6 (18.1)	100 (95.6)^{AB}	100 (99.2)^{A}	100 (97.2)^{A}	100 (97.9)^{A}	100 (92.4)^{A}
Actara 25WG	8g.p (2g.a.i.)	13.3 (21.4)	100 (91.2)^{AB}	99.3 (85.2)^{BC}	100 (91.3)^{AB}	99.3 (85.3)^{B}	98.5 (82.8)^{BC}
Actara 25WG	6g p (1.5g. a.i)	14.3 (22.2)	98.3 (82.5)^{BC}	93.6 (75.3)^{CD}	94.6 (76.5)^{C}	86.8 (68.7)^{C}	92.7 (74.3)^{CD}
Confidor 200SL	20ml (4g. a.i)	11.4(19.7)	100 (99.6)^{A}	100 (99.6)^{A}	100 (99.8)^{A}	100 (92.9)^{AB}	100 (99.2)^{A}
Confidor 200SL	15ml (3g. a.i)	13 (21.1)	94.6 (76.4)^{C}	99.9 (89.9)^{AB}	100 (90.1)^{AB}	90.7 (72.3)^{C}	100 (90.0)^{AB}
Confidor 200SL	10ml (2g. a.i)	12 (21)	91.9 (73.5)^{C}	90.4 (72)^{D}	95.9 (78.3)^{BC}	79.8 (63.3)^{C}	88.3 (70)^{D}
Untreated control	water only	11 (20.2)	8.3 (16.7)^{D}	10.7 (19.1)^{E}	14 (22.0)^{D}	23.9 (29.3)^{D}	25.1 (30.1)^{E}
		1.99	3.77	2.89	3.72	3.34	2.62
SE±		16.8	8.5	6.5	8.1	8	5.9
C.V%							
B: Immature stages							
Actara 25WG	10g.p (2.5g.a.i)	14.4 (22)	100 (99.6)^{A}	100 (99.7)^{A}	100 (99.4)^{A}	100 (95.6)^{AB}	100 (98.1)^{AB}
Actara 25WG	8g.p (2g.a.i.)	16.5 (24.1)	100 (96.8)^{A}	100 (92.5)^{AB}	100 (92.4)^{B}	99.8 (88)^{AB}	99.6(86.6)^{ABC}
Actara 25WG	6g p (1.5g. a.i)	15.3 (23)	100)93.8)^{AB}	100 (91.3)^{B}	99.9 (88.7)^{B}	91.2 (72.7)^{CD}	99.2(85)^{C}
Confidor 200SL	20ml (4g. a.i)	13.4 (21.5)	100 (99.2)^{A}	100 (99.6)^{A}	100 (99.7)^{A}	100 (99.7)^{A}	100 (99.1)^{A}
Confidor 200SL	15ml (3g. a.i)	17 (24.4)	99.2 (85.2)^{BC}	100 (92.7)^{AB}	95.4 (77.7)^{C}	98.4 (82.7)^{BC}	99.4 (85.7)^{BC}
Confidor 200SL	10ml (2g. a.i)	15.4 (23.1)	97.9 (81.7)^{C}	96.7 (79.6)^{C}	87.2 (69)^{D}	78.4 (62.3)^{D}	94.4 (76.3)^{C}
Untreated control	water only	9.3 (17.8)	19.9 (26.5)^{D}	21.4 (27.6)^{D}	21.6 (27.7)^{E}	22.8 (28.5)^{E}	25.5 (30.3)^{D}
		1.46	2.57	2.12	1.45	3.93	3.56
SE±		11.3	5.4	4.4	3.2	9.0	7.7
C.V%							

-Data in brackets were arcsine transformed.
-Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test.

(Table 1) was significantly increased for all insecticides used compared with untreated control throughout the experimental period. The higher doses of insecticides resulted in the higher number of dead insects. Similar results were obtained in the second season (2004 /2005) in El Golid (Table 3) when Actara and Confidor as well as Rinfidor 20%SL and Comodor 20%SL were used. The higher doses were superior to the lower doses and the untreated control in number of total dead insects even 12 weeks after application (the last count).

Results of percentage mortality of adult females and immature stages in the first season in 2003 / 2004 season (Table 2 and Fig. 1) showed the high efficacy of insecticides as reflected by the hundred percent mortality of adult female and immature stages during the second week after injection throughout the rest of counts. Similar results were obtained in the second season (2004 / 2005) as show in Table 4, Table 5 and Fig. 2. The new imidacloprid commercial compounds, Rinfidor and Comodor, showed an effective performance similar to Confidor.

3.2.2 Yield and yield components

Results in Table 6 indicate that, all doses of different insecticides significantly affected yield and physical characters of date's fruits compared to the untreated control. The higher doses of Actara (10g) and Confidor (20ml) resulted in higher fruit weight, fruit length and a lower seed/ fruit weight percentage indicating a higher yield. An increase in yield (75%) was observed relative to the untreated control.

Results of the second season 2004 / 2005 at El Golid (Table 7) confirmed the above mentioned results. All treatments were superior to the untreated control in yield

Table (3) Mean biweekly total mortality of green pit scale insect from tree treated with different insecticides (using trunk injection method), at El Golid, season 2004/2005.

Insecticides	Dosage rate/ palm	No. of dead scales at weeks after injection					
		0	2	4	6	8	12
Actara 25WG	10g.p (2.5g.a.i)	0.51(1.0)	7.7 (2.8)^{A}	8.5 (3.0)^{A}	5.7 (2.5)^{A}	3.7 (2.0)^{AB}	5.3 (2.4)^{A}
Actara 25WG	8g.p (2g.a.i.)	0.71 (1.1)	3.5 (2.0)^{B}	4.3 (2.2)^{BC}	3.1 (1.9)^{CD}	2.4 (1.7)^{BC}	3.4 (1.9)^{BC}
Actara 25WG	6g p (1.5g. a.i)	0.6 (1.1)	2.7 (1.8)^{BCD}	3.1 (1.9)^{C}	2.4 (1.7)^{DE}	1.3 (1.3)^{CD}	2.3 (1.7)^{CD}
Rinfidor 20%SL	20ml (5g. a.i)	0.7 (1.1)	6.3 (2.6)^{A}	5.8 (2.5)^{B}	4.3 (2.2)^{AB}	3.5 (2.0)^{AB}	3.9 (2.1)^{AB}
Rinfidor20%SL	15ml (4g.a.i)	0.9 (1.2)	3.3 (1.9)^{BC}	3.1 (1.9)^{C}	2.4 (1.7)^{DE}	2.5 (1.7)^{BC}	3.1 (1.9)^{BC}
Rinfidor20%SL	10ml (3g.a.i)	0.9 (1.2)	1.8 (1.5)^{D}	1.5 (1.4)^{D}	1.7 (1.3)^{E}	1.2 (1.3)^{CD}	2.3 (1.7)^{CD}
Comodor20%SL	20ml (5g.a.i)	1.1 (1.3)	6.8 (2.7)^{A}	5.4 (2.4)^{B}	4.8 (2.3)^{AB}	4.3 (2.2)^{A}	4.3 (2.2)^{AB}
Comodor20%SL	15ml (4g.a.i)	0.9 (1.1)	3.9 (2.1)^{B}	3.5 (2.1)^{C}	2.9 (1.8)^{D}	2.6 (1.8)^{ABC}	3.1 (1.9)^{BC}
Comodor20%SL	10ml (3g.a.i)	1.1 (1.2)	2.1 (1.6)^{CD}	1.8 (1.5)^{D}	2.4 (1.7) ^{DE}	1.9 (1.5)^{CD}	2.4 (1.7)^{CD}
Confidor 200SL	20ml (5g.a.i)	1.1 (1.3)	7.3 (2.8)^{A}	7.9 (2.9)^{A}	4.2 (2.2)^{AB}	3.9 (2.1)^{AB}	3.1 (1.9)^{BC}
Confidor 200SL	15ml (4g.a.i)	0.9 (1.1)	3.5 (2.0)^{B}	4.3 (2.2)^{BC}	1.9 (1.5)^{E}	1.4 (1.4)^{CD}	2.1 (1.6)^{CD}
Confidor 200SL	10ml (3g.a.i)	1.0 (1.2)	2.1 (1.0)^{D}	3.1 (1.9)^{C}	1.7 (1.5)^{E}	1.0 (1.2)^{D}	1.5 (1.4)^{DE}
Untreated control	water only	0.9 (1.1	0.5 (1.0)^{E}	0.7 (1.1)^{E}	0.5 (1.0)^{F}	1.0 (1.2)^{D}	0.5 (1.0)^{E}
SE±		0.14	0.10	0.11	0.1	0.13	0.12
C.V%		24.6	8.7	9.2	8.4	14.1	11.7

-Data in brackets were √x+0.5.
-Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table (4) Mean biweekly percentage of adult females of green pit scale insect from trees treated with different insecticides (using trunk injection method) at El Golid, season 2004/2005.

Insecticides	Dosage rate/ palm	% Mortality of scales at weeks after injection					
		0	2	4	6	8	12
Actara 25WG	10g.p(2.5g.a.i)	23.1 (28.7)	91 (72.8)^{A}	98.6 (88.4)^{A}	95.8 (76.6)^{ABC}	100 (98.5)^{A}	99.6 (86.5)^{A}
Actara 25WG	8g.p (2g.a.i.)	22.9 (28.5)	89.0 (70.8)^{A}	91.5 (73.4)^{ABCD}	87.2 (69.0)^{ABC}	100 (98.6)^{A}	100 (95.7)^{A}
Actara 25WG	6g p (1.5g. a.i)	27.0 (31.3)	69.4 (56.4)^{BC}	87.7 (69.5)^{ABCD}	65.3 (53.9)^{CD}	100 (97.9)^{AB}	99.8 (87.2)^{A}
Rinfidor 20%SL	20ml (5g. a.i)	13.6 (21.7)	89.2 (70.8)^{A}	80.0 (97.0)^{ABC}	100 (98.0)^{A}	100 (99)^{A}	100 (97.7)^{A}
Rinfidor20%SL	15ml (4g.a.i)	12.3 (20.5)	61.4 (51.6)^{C}	77.2 (61.5)^{BCD}	100 (99.0)^{A}	98.9 (84.4)^{AB}	100 (99.2)^{A}
Rinfidor20%SL	10ml (3g.a.i)	20.7 (27.1)	51.6 (45.9)^{C}	72.4 (58.0)^{CD}	98.7 (83.7)^{ABC}	91.2(80.5)^{AB}	97 (80)^{A}
Comodor20%SL	20ml (5g.a.i)	23.2 (28.8)	88.7 (70.4)^{A}	97.6 (81.2)^{ABC}	100 (94)^{AB}	100 (99.2)^{AB}	100 (99.5)^{A}
Comodor20%SL	15ml (4g.a.i)	14.7 (22.6)	66.8 (54.8)^{C}	85.3 (67.3)^{ABCD}	100 (91)^{AB}	96 (78)^{BC}	100 (98)^{A}
Comodor20%SL	10ml (3g.a.i)	13.7 (21.7)	50.9 (45.5)^{C}	67.0(54.0)^{D}	78 (62.0)^{BC}	92 (74.7)^{AB}	100 (91.9)^{A}
Confidor 200SL	20ml (5g.a.i)	19.9 (26.3)	86.6 (67.7)^{AB}	100 (91.0)^{A}	100 (99)^{A}	100 (99.4)^{A}	100 (99.7)^{A}
Confidor 200SL	15ml (4g.a.i)	27.9 (31.9)	70.4 (57.0)^{BC}	99.5 (86.0)^{AB}	98.7 (83)^{ABC}	100 (99.5)^{A}	100 (98)^{A}
Confidor 200SL	10ml (3g.a.i)	11.9 (20)	70.6 (57.2)^{BC}	84.8 (67.1)^{ABCD}	89.1 (71.9)^{ABC}	89.2 (71)^{B}	100 (91)^{A}
Untreated control	water only	17.3 (24.6)	15.0 (22.0)^{D}	19.0 (24.9)^{E}	25.7 (30.6)^{D}	19.2 (26)^{C}	13.3 (21.4)^{B}
SE±		3.76	3.47	7.13	9.75	6.32	6.26
C.V%		25.4	10.5	17.8	21.6	12.8	12.3

-Data in brackets were arcsine transformed.
-Means with letter(s)} in common are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table (5) Mean biweekly percentage mortality of immature stages of green pit scale insect from trees treated with different insecticides (using trunk injection) at El Golid, season 2004/2005.

Insecticides	Dosage rate/ palm	% Mortality of scales at weeks after injection					
		0	2	4	6	8	12
Actara 25WG	10g.p (2.5g.a.i)	8.2 (16.6)	100(99.3)^{A}	100(98.4)^{A}	100(99.6)^{A}	100(98.1)^{A}	100(98)^{A}
Actara 25WG	8g.p (2g.a.i.)	20.8 (27.1)	97.8 (81.4)^{ABC}	100(95.2)^{A}	100(99.6)^{A}	100(96.3)^{A}	100(96.2)^{A}
Actara 25WG	6g p (1.5g. a.i)	2.5 (9.1)	96.3(78.9)^{BC}	100..(92.1)^{A}	100(99.1)^{A}	98.6(83.3)^{B}	99.7(86.9)^{A}
Rinfidor 20%SL	20ml (5g. a.i)	23.2 (28.8)	100(99)^{A}	100(95.4)^{A}	100(98.2)^{A}	100(99.2)^{A}	100(97.5)^{A}
Rinfidor20%SL	15ml (4g.a.i)	9.9 (18.3)	99.9(88.3)^{AB}	100(97.7)^{A}	100(98.9)^{A}	100(97.8)^{A}	100(99.2)^{A}
Rinfidor20%SL	10ml (3g.a.i)	4.5 (12.3)	85.5(67.6)^{C}	100(90.7)^{A}	98.2(82.3)^{B}	100(99.3)^{A}	100(97.2)^{A}
Comodor20%SL	20ml (5g.a.i)	25.6 (30.4)	100(99.5)^{A}	100(98.5)^{A}	100(99.3)^{A}	100(99.2)^{A}	100(98.5)^{A}
Comodor20%SL	15ml (4g.a.i)	1.5 (1.4)	100(99.4)^{A}	100(98.4)^{A}	100(96.2)^{A}	100(98.6)^{A}	100(99.1)^{A}
Comodor20%SL	10ml (3g.a.i)	0.4 (1.0)	97.9(81.6)^{ABC}	100(95.2)^{A}	100(90.9)^{A}	100(98.7)^{A}	100(99.5)^{A}
Confidor 200SL	20ml (5g.a.i)	25.2 (30.1)	100(99.3)^{A}	100(99.3) ^{A}	100(99.6)^{A}	100(99.4)^{A}	100(98.^{A}
Confidor 200SL	15ml (4g.a.i)	11.7 (20.0)	100(98.9)^{A}	100(98.8)^{A}	100(99.4)^{A}	100(99.4)^{A}	100(99.4)^{A}
Confidor 200SL	10ml (3g.a.i)	12.4 (20.6)	100(97.3)^{A}	100(98.1) ^{A}	100(95.3)^{A}	100(99.2)^{A}	63.5(52.8)^{B}
Untreated control	water only	17.5 (24.8)	22.3(28.2)^{D}	24.4(29.6)^{B}	24(29.3)^{C}	23.2(28.8)^{C}	24.3(29.5)^{C}
SE±		4.8	5.23	3.47	2.73	2.66	7.22
C.V%		45.3	10.5	6.6	5.2	5.0	14.1

-Data in brackets were arcsine transformed.
-Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table (6) Yield and yield components of date fruits from trees treated with different insectices (using trunk injection) at Elgaba scheme, season 2003/2004.

Insecticide	Dosage rate/ palm	% ripe fruit	Fruit weight (g)	Fruit length (cm) L	Fruit diam-eter (cm) D	L/D ratio	% seed/ Fruit wt.	Yield kg/ palm
Actara 25WG	10g.p (2.5g.a.i)	100^{A}	7.2^{A}	4.9^{A}	1.6	3.0	9.3^{D}	109^{A}
Actara 25WG	8g.p (2g.a.i.)	93.3^{AB}	6.8^{AB}	4.9^{A}	1.5	2.9	11.3^{BC}	85.5^{ABC}
Actara 25WG	6g p (1.5g. a.i)	85^{BC}	6.2^{B}	4.3^{BC}	1.7	2.8	12.7^{B}	81.77^{ABC}
Confidor 200SL	20ml (4g. a.i)	100^{A}	7.6^{A}	4.7^{AB}	1.6	3.0	10^{CD}	103.67^{AB}
Confidor 200SL	15ml (3g. a.i)	86.7^{BC}	7.4^{AB}	4.6^{AB}	1.6	2.9	11.7^{BC}	63.67^{BCD}
Confidor 200SL	10ml (2g. a.i)	80^{C}	7.0^{AB}	4.5^{AB}	1.5	2.8	12.3^{B}	57.77^{CD}
Untreated control	water only	48.3^{D}	4.9^{C}	3.9^{C}	1.5	2.6	15.7^{A}	28.3^{D}
SE±		2.47	0.37	0.14	0.06	0.17	0.56	11
C.V%		5.0	9.5	5.6	6.5	9.9	8.1	25.1

Means with letter(s) in common are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table (7) Yield and yield components on date fruits from trees treated with different insecticides (using trunk injection method) at El Golid, season 2004/2005.

Insecticides	Dosage rate/ palm	%ripe fruit	Fruit wt. (g)	Fruit length (cm) L	Fruit diameter. (cm) D	L/D Ratio	%seed per fruit wt.	Yield kg/ palm
Actara 25WG	10g.p (2.5g.a.i)	100^{A}	7.3^{A}	4.6^{A}	1.6^{A}	3.0^{A}	9.3^{FG}	97.3^{AB}
Actara 25WG	8g.p (2g.a.i.)	86.7^{BCD}	7.1^{AB}	4.1^{ABCD}	1.6^{A}	2.6^{ABCD}	12.7^{BCDEF}	87.3^{BC}
Actara 25WG	6g p (1.5g. a.i)	70^{EF}	6.9^{ABC}	3.4^{EF}	1.6^{A}	2.1^{CD}	8.3^{G}	79^{CDE}
Rinfidor 20%SL	20ml (5g. a.i)	$90A^{BC}$	5.7^{ABCD}	4.2^{ABC}	1.4^{AB}	3.0^{A}	11.3^{DEFG}	96^{AB}
Rinfidor20%SL	15ml (4g.a.i)	83.3^{CD}	5.4^{BCD}	3.7^{BCDE}	1.6^{A}	2.3^{ABCD}	14.7^{ABCD}	86^{BCD}
Rinfidor20%SL	10ml (3g.a.i)	65.1^{F}	5.1^{CD}	3.5^{DEF}	1.4^{AB}	2.6^{ABCD}	16.3^{AB}	72.7^{E}
Comodor20%SL	20ml (5g.a.i)	96.7^{AB}	5.9^{ABCD}	4.1^{ABCD}	1.6^{A}	2.6^{ABCD}	9.7^{EFG}	96.7^{AB}
Comodor20%SL	15ml (4g.a.i)	80^{CDE}	5.1^{CD}	3.7^{CDE}	1.4^{AB}	2.5^{ABCD}	13.3^{BCDE}	75.7^{DE}
Comodor20%SL	10ml (3g.a.i)	60^{F}	4.7^{D}	3.4^{EF}	1.3^{B}	2.8^{ABC}	14.7^{ABCD}	68^{E}
Confidor 200SL	20ml (5g.a.i)	100^{A}	5.9^{ABCD}	4.3^{AB}	1.5^{AB}	3.1^{AB}	10^{EFG}	99.7^{A}
Confidor 200SL	15ml (4g.a.i)	83.3^{CD}	5.3^{BCD}	3.6^{DE}	1.6^{A}	2.2^{BCD}	11.7^{CDEFG}	86.3^{BCD}
Confidor 200SL	10ml (3g.a.i)	78.6^{DE}	4.2^{D}	3.2^{DEF}	1.4^{AB}	2.2^{BCD}	15.3^{ABD}	68.7^{E}
Untreated control	water only	50^{G}	4.3^{D}	3.1^{F}	1.4^{AB}	1.9^{D}	18.3^{A}	24.7^{F}
SE±		3.15	0.51	0.18	0.07	0.21	1.13	3.28
C.V%		6.8	15.8	8.4	8.2	14.5	15.4	7.1

Means with letter(s) in common are not significantly different at 5 % level according to Duncan's Multiple Range Test.

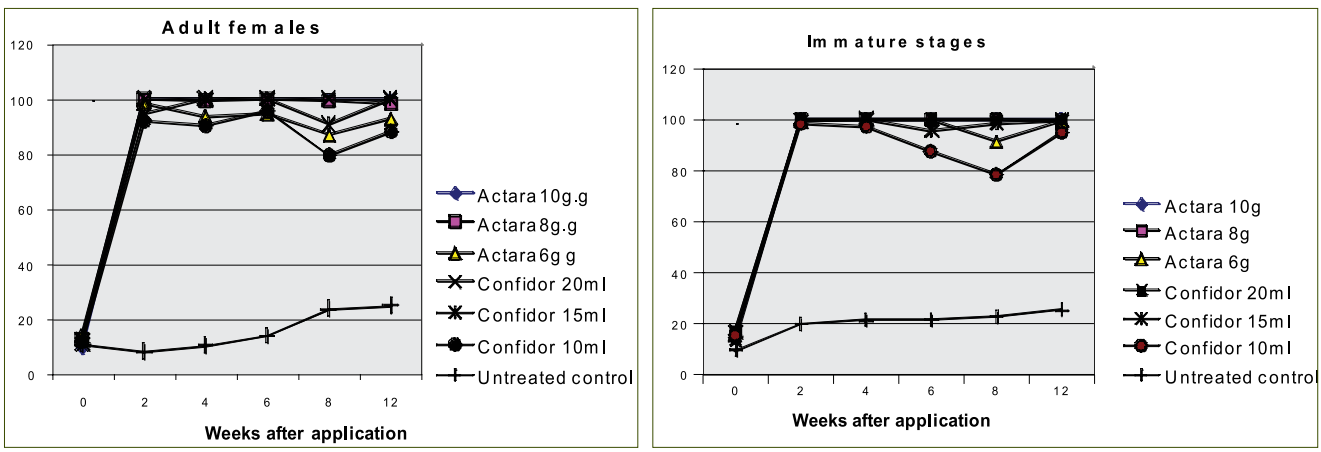


Fig.1: Mean biweekly percentage mortality of adult females and Immature stages of green pit scale insect from trees treated with trunk injected insecticides in Elgaba scheme season, 2003/2004.

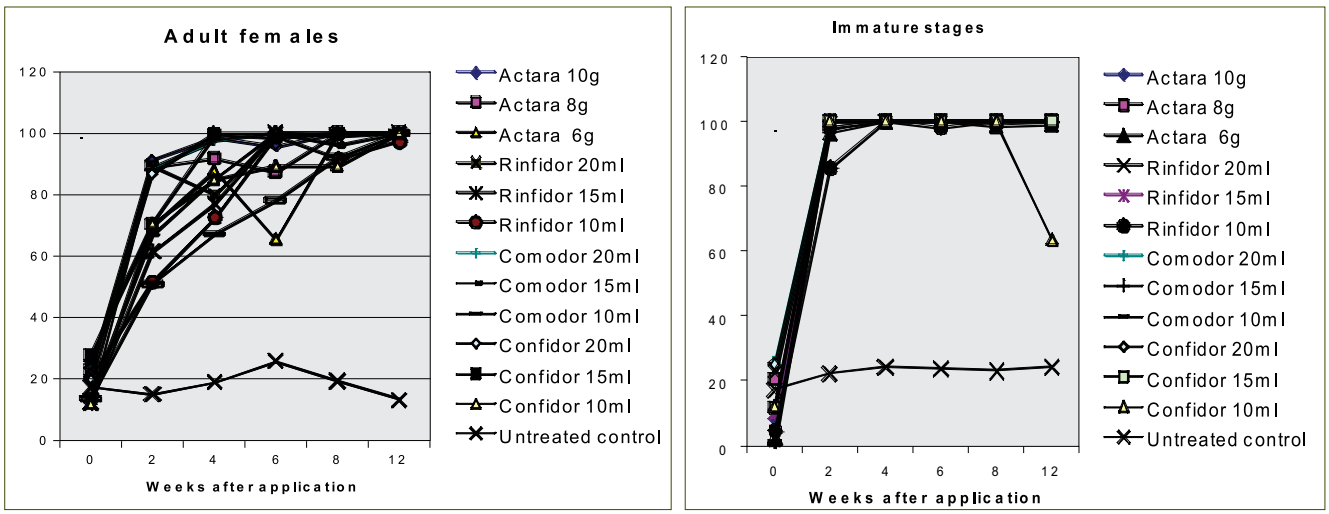


Fig.2: Mean weekly percentage of adult females and immature stages of green pit scale from trees insect treated with trunk injected insecticides, El Golid, season 2004/2005.

and yield components except the fruit diameter and percentage seed / fruit weight. The higher yields (kg / tree) were observed in the higher doses of different insecticides.

3.3 Results of residue analysis

Rinfidor 20% SL, Comodor 20% SL and Confidor 200 SL are formulation of imidacloprid [1-(6-chloro-3-pyridylmethyl)-N-nitroimidazoldin-2-ylideneamine)]. Results of residue analysis indicated that, the residues of imidacloprid and its metabolites were below the detection limit (0.09 µg) in all samples analyzed. The Rf of imidacloprid was 0.53. This result indicated that the usage of Rinfidor 20 % SL, Comodor 20 % SL and Confidor 200 SL at the rate of 35 ml/ tree on the date palms are safe for human consumption.

According to the TLC results the Rf value for thiamethoxam standard was 0.56. The minimum detectable amount of Thiamethoxam standard was 0.1 µ g. The recovery of the method was 85 % No residues of Thiamethoxam and metabolites were detected in all samples examined.

4: DISCUSSION

4.1 Trunk injection method

In the past, and due to lack of indigenous knowledge of appropriate control measures adopted to control the date palm green pit scale insect, in Sudan, the treatment control efforts were not successful; hence the level of infestation steadily increased. Following intensive research efforts since the year 2000, this study identified a systemic insecticides of new generation, Neonicotinoid insecticides (thiamethoxam and imidacloprid) such as Confidor 200 SL and Actara 25 WG which proved high effectiveness in controlling the green pit scale insect in the infested trees, through integrated pest management starting with cultural practices or sanitary measures, supplemented with chemical control and impact of natural enemies together with plant quarantine legislations.

Results of insect mortality, yield and yield components obtained from the two seasons (2003/2004 and 2004/2005) indicated that, trunk injection was an effective and reliable method for controlling the green pit scale insect. The higher doses treatments; Actara (10g), Rinfidor (20ml), Comodor (20ml) and Confidor (20ml) were superior to the lower doses and the untreated control in number of total dead insects and percentage mortality, even 12 weeks after application (the last count). Results of percentage mortality of adult females and immature stages showed the high efficacy of insecticides as reflected by the hundred percent mortality of adult female and immature stages during the second week after injection.

The same finding were obtained by Joseph et.al (2003 and 2007) when they test a trunk Micro-infusion of IMA-jet (imidacloprid) for control the Hemlock Woolly Adelgid (a tiny, piercing and sucking insect) that feed on Hemlock twings.Results indicate that, Adelgid mortality may occur with 14-28 days and continue for up to 2 years.Hemolocks respond to treatment with a resumption of growth. On the other hand, Smitly et.al (2006) success in controlling Emerald Ash Borer (Agrilus planipennis Fairmaire) infesting green Ash trees (Fraxinus pennsylvanica Marsh) with

trunk injection using either imidacloprid (Mauget imidide and Arborjet IMA-jet), or orthen (Acecaps).Results indicate that the Arborjet trunk injection treatments with imidacloprid provided a high level of control (92-100%).Acecaps trunk injection containing acephate, gave 76% control.

Fernandes Cordova and Gallego (1997) found that oaks infested by oak scale insect were cured by injection with prepared capsules of 225ml Acephate or imidacloprid solution, these insecticides were effective in controlling the scale pest, moreover, they pointed out that greater than 79% control of oak scale was obtained when acephate and imidocloprid were injected at rates of 7.5g a.i. and 0.8ml per tree respectively. Mathen and Kurian (1977) pointed out that seven at a concentration of 1% injected in coconut trunk cased 93% reduction in the infestation level of red palm weevil.

The distribution rates of the thiamethoxam as Actara 25 WG 24 h. post injection of 1 and 2 g a.i./palm (Al-Sammariae et.al,2006) showed that it distributed into the sap and it was detect in the injection side and also in the opposite side at different heights. The result indicated that thiamethoxam translocate rapidly into date palm trunk and reaches the leaves in a short time so it can be drown out of the findings that it can be employs as a fast chemical remedy against most palm insect pests.

As mentioned before, trunk injection requires the use of a systemic insecticide. It is a safe method which affects the pest only without any side effect on natural enemies. Thus the method causes little adverse effects on the environment, when wide spray application with contact insecticides using aircrafts and heavy machinery had been conducted in areas like El Golid the pest recovered within one year and spread from the target area to infest Elgaba scheme and Old Dongola (Obied, 1987, El Fahal et.al., 1993 and Ahmed, 2003). Furthermore, trunk injection protects the insecticide from adverse climatic factors. If we take into consideration that more than 60% of date palm trees in the Sudan are not irrigated, the use of trunk injection is very useful as an alternative solution to soil application method.

This method not only increases user's safety, it also allows the work to be carried out in an extremely economical manner. The dose used is decreased to less than 50% compared to soil application. On the other hand, a three- man team can do the work, one man boring the hole, the second inserting the tube into the holes and the third inject insecticides and close tubes. Date palms treated by trunk injection, continued to develop normally during the past four seasons. No phytotoxicity had been observed till now in the treated trees. No insecticide residues have been detected either in dates, soil or grasses.

Insecticides are applied through direct injection into the trunk of the date palm to control the red palm weevil (Oihabi, 2003). The influence of injector size, tree species, and season on uptake of injected solution, uptake volume varied among species and injector size, but it usually increased with time. Uptake volume usually decreased as injector diameter decreased. In nonresinous species, the 6 mm (0.24 in.) injector gave the best results, but the 4 mm (0.16 in.) and the 3 mm (0.12 in.) injectors also gave acceptable results. Rubidium content increased over time in sampled needles. One day after injection, Rb+ was recovered in all three sections, indicating a homogeneous distribution throughout the tree (Al-Jboory et.al.2001).

Distribution of injected materials throughout the tree is an important factor that may limit the use of the technique because chemicals may accumulate in one part of the tree and not in others. Many factors, including hole depth, injection placement, tree structure, and the number of injections per tree, affect the distribution of solutions (Sachs et al., 1977and Navarro et al., 1992). The injection method also affects distribution. Today, the tendency is to use low-pressure systems comprising individual devices on each injection point in order to control the quantity of material applied on each point (Whiley et. al., 1991; McClure, 1992 and Navarro et. al., 1992).The injector could be reduced in size to 4 mm (0.16 in.) in diameter for use in nonresinous species, but length must be increased to 70 mm (2.8 in.) to inject trees with thick bark and to reach the xylem without damaging the trunk.

Coniferous species are less effectively injected than angiosperms (Sachs et .al., 1977 and Reil, 1979). The difference is explained by the wood structure. Conifer xylem is composed primarily of tracheids with greater resistance to water movement than angiosperms, in which the xylem contains large-diameter, vertical vessels. In addition, some coniferous species produce resin in response to tree wounds, which may affect water uptake. For these reasons, trunk injections in conifers are less frequent than in angiosperms, and less information is available on the factors affecting uptake and distribution of injected solutions in these species. Joseph et.al (2007) stated that, uptake occurs when trees are transpining.The environmental conditions that favor uptake are moderate temperature, adequate soil moisture and high humidity. Generally hot weather and dry soil conditions will results in a reduced rate of uptake. Micro-infusion time varies depending on the season, time of day, environmental conditions and tree health. The average uptake time for hemlock treatment is 30 minutes. So the correct time of injection (April-June) and cultural practices (removal of the dead leaves and the highly infested leaves in the lowest rows and normal

irrigation) recommended by our study are conformed by these findings.

Riad et.al (2007) in Irag designed local trunk injector for date palm tree. Many injectors worldwide were manufactured for that purpose, such as Arbocap (www.arbocap.net) .The correct use as follows: 1) Preparing the insecticide 2) Charging the containers spring-mechanism, aspirate up to the 40ml mark and aspirating will be continue a further 10 ml of air. 3) A hole in the trunk (to a depth of 3 cms approx.) will be drilled using a 3.5 mm drill hit for steal. 4) Arbocap will be inserted to a depth of 0.5 cm using rubber or plastic tipped hammer.5) Pressure will be produce by freeing Arbocaps spring-mechanism. 6) After complete absorption of the chemical Arbocap will be extracted and the hole will be disinfected.

Imidacloprid and thiamethoxam application through trunk injection is highly economical, as indicated that, the best doses of each compounds (20ml / tree and 10g / tree for imidacloprid as Confidor and thiamethoxam as Actara respectively) was lower the dose used in soil application method (35ml / tree and18g/tree) by 57% and 55% for imidacloprid and thiamethoxam ,respectively.

Therefore the current work support the believes that there is a remarkable opportunities to inject Actara and other systemic pesticides directly in palm trunk and it will translocate in appropriate time and can fit well with date palm pests control program. One hole and one injection at adequate concentration could be enough to distribute Actara in palm tree within less than 24 hours could obtain efficient curing concentration.

4.2 Residues analysis of the tested compounds

The pesticide trunk injection technique which looks environmentally sound is widely demonstrated in date palm pest control programs. The success of this technique based on the ability of the injected pesticide to translocate in palm sap (xylem and phloem) and provides an adequate concentration levels within appropriate time to keep the pest infestation intensity below the economic threshold.

Rinfidor 20% SL, Comodor 20% SL and Confidor 200 SL are formulation of imidacloprid [1-(6-chloro-3-pyridylmethyl)-N-nitroimidazoldin-2-ylideneamine)]. Results of residue analysis indicated that, the residues of imidacloprid and its metabolites were below the detection limit (0.09 µg) in all samples analyzed. The Rf of imidacloprid was 0.53. This result indicated that the usage of Rinfidor 20 % SL, Comodor 20 % SL and Confidor 200 SL at the rate of 35 ml/ tree on the date palms are safe for human consumption.

According to the TLC results the Rf value for thiamethoxam standard was 0.56. The minimum detectable amount of thiamethoxam standard was 0.1 µ g. The recovery of the method was 85 % No residues of Thiamethoxam and metabolites were detected in all samples examined. Therefore, it is concluded that the use of Actara 25 WG on date palms may be safe if used at the recommended dose. It is known that rapid metabolism of thiamethoxam occurs in plants with two main major metabolites, which are of no toxic effect. In the field soil degradation of thiamethoxam is fast with half-life about four weeks. It gives one major metabolite and finally mineraled to carbon dioxide (Albert and Naeun, 2000).

Results of the date samples in Dammam area in Saudi Arabia collected after 6 weeks from treatment with Confidor 5 G at100 g /tree and 20 ml /tree for control the Red Palm Weevil, did not show any Confidor residues (Alawi, 1993). The study recommends that, these chemicals can be used before six weeks from the date of harvesting of fruits (Sherif, 1994).

Speed translocation of the systemic insecticide thiamethoxam (Actara 25GW) was investigated (Al-Sammariae et.al,2006) post injection of 4, 8, and 12g which represent 1, 2 and 3g a.i. (active ingredient) per plant moreover; the concentrations in sap, leaves and dates were monitored at different intervals. The insecticide qualitative and quantitative analysis were determined by employing ELISA and HPLC techniques. The results revealed following the injection of 12g/palm that Actara moved up in palm trunk sap at a rate of 2.8 m/h and the concentrations in pith and sap which been collected from sampling pore (1.4m above injection point) were 0.64 ppm and 2.939 ppm after 30 and 90 minutes respectively, this indicate that actara rapidly moved out of the injection point and diffused into the palm sap. On other hand the insecticide was detect in leaves (0.093 ppm) and in dates (0.016ppm) at 240 minutes post injection and being 0.022 ppm and 0.008 ppm after 33 days respectively.

5: CONCLUSION AND RECOMENDATIONS

Conclusion

1- Date palm production and plantations in Sudan , considerably deteriorated in the last years as a result of biotic and abiotic stresses, among which the green pit scale is the most important.

2- Trunk injection of imidacloprid (Confidor 200SL, Rinfidor 20%SL and Comodor 20%SL) and thiamethoxam (Actara 25WG) were highly effective in controlling the green pit scale insect.

3- It proved to be very effective as a protective measure against new infestation.

4- This method of application do not require any expensive machinery or labour for application. It can be safely applied.

5- Trunk injection truly effective and

reliable method for controlling the green pit scale insect, with minimal environmental impact.

6- This method of application is highly economical and safe for the user and appear to be safe for the beneficial insects.

7- Date palms treated with different insecticides using the this method, developed normally during four seasons. No phytotoxicity has been noticed in the treated trees.

8- The tested insecticides checked termites and many other pests, but did not affect mites.

Recommendations

Based on the results, the following insecticides with given dosage rates are recommended for control the date palm green pit scale insect, using trunk injection method of application:

1) Actara25WG (thiamethoxam) 10g product / tree (2.5 g a.i.)

2) Rinfidor 20%SL (imidacloprid) 20 ml product / tree (4g a.i.)

3) Comodor 20%SL (imidacloprid) 20 ml product / tree (4g a.i.)

4) Confidor 200SL (imidacloprid) 20 ml product / tree (4g a.i.)

Removal of the dead leaves and the highly infested leaves in the lowest rows and normal irrigation must be applied.

The common names, trade names, toxicity data and supplier of the tested insecticides are shown in Table (8).

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Table (8)Trade and common names, toxicity and suppliers of the tested insecticides.

Trade name	Common name	Chemical name	Toxicity				Suppliers	
			Acute oral LD_{50} (mg / kg) (Rat)	Acute dermal LD_{50} (mg/ kg) (Rat)	Acute Inhalation LC_{50} 4h. (Rat)	Skin irritation (Rabbit)	Principal Company	Local Agent
Actara 25WG	thiamethoxam	3-(2-chloro-thiazol-5-ymethyl-[1,3,5] oxodiazinan-4ylidene-N-nitroamine	1563	>2000	3720	Not irritant	Syngenta (Switzerland)	SySyngenta (Sudan)
Rinfidor 20%SL	imidacloprid	1(6-chloro-3-pyridyl methyl)-N-nitroimidazolidin-2-ylideneamine	450	>5000	5323	Not irritant	Agromen chemical Co LTD (China)	Riham International Co. LTD
Comodor 20%SL	imidacloprid	1(6-chloro-3-pyridyl methyl)-N-nitroimidazolidin-2-ylideneamine	450	>5000	5323	Not irritant	Madmac (Jordan)	Green Deel
Confidor 200SL	imidacloprid	1(6-chloro-3-pyridyl methyl)-N-nitroimidazolidin-2-ylideneamine	450	>5000	5323	Not irritant	Bayer (Germany)	MADCO

SL) against the green date palm pit scale insect (Asterolecanium phoenicis Rao.) (Homoptera: Asterolecaniidae). The proceeding of the international date palm conference. 16-19 September 2003, Faculty of Agricultural Sciences and Vetrinary El Gassim, King Saud University, K.S.A.

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Dr. Mohamed Saeed Gassouma
UAE Ministry of Agriculture
and Fisheries

saeedgassouma@hotmail.com

Arthropod Pests of the Date Palm (Phoenix dactylifera L.)

Abstract

The date palm, like no other fruit tree, is parasitized by a comparatively large number of pests: some of them are indigenous to the region like the "Dubas Bug" Ommatissus lybicus, the white scale Parlatoria blanchardii, the red scale Phoenicococcus marlatti, the trunk borer Jebusaea hammerschmidii and the two rhinoceros beetles Oryctes agamemnon and O. elegans. Some are recently imported with planting material like the dreaded. Red Palm Weevil Rhynchophorus ferrugineus, the third rhinoceros beetles Oryctes rhinoceros and the long scale Fiorinia phoenicis. There is also the new pest (and also a new species) the inflorescence beetle Macrocoma sp. discovered and described by the author in UAE.

Some of these pests weaken the palm and reduce its produce:

- Dubas Bug; Ommatissus lybicus
- The scale insects: Parlatoria blanchardi,

Phoenicococccus mar-latti, Fiorina phoenicis and the Green Scale Palmapsis phoenicis.

- The "giant" meanly bug: Pseudaspidoproctus hypheniacus
- The crimson mite: Raoiella indica.

Others directly attack and damage the fruits (dates):

- The inflorescence beetle; macrocoma sp. nov
- The dried fruits beetle: Carpophilus dimidiatus
- The date moth (humeira): Batrachedra amydraula
- The inflorescence moth: Aphomia (Arenipses) sabella
- The oriental wasp: Vespa orientalis
- The date mite: Oligonychus afrasiticus

Others attack the trunk and / or the roots and eventually kill the palm:

- The Red Palm Weevil: Rhychophorus ferrugineus
- The long horn trunk borer : Jebusaea hammerschmidtii
- The rhinoceros beetle: Oryctes Agamemnon
- The termite: Odontotermes smeathmani

Some are "pests in transit"; The frond beetles: Julodis fimbriata and J. caillaudi.

The paper is composed of a pictorial and textual presentation of morphology, life cycles, damage done and control measures for the different pests. All the pests are from UAE orchards, except the termite and the green scale which are from Sudan.

Introduction

All pests to be mentioned in the presentation are from UAE farms, except the Green Scale (Palmaspis phoenicis) and the termite (Odontotermes smeathmani), which are from Sudan.

A number of arthropod pests attack the date palm; some appear in seasonal generations and then disappear after each generation, leaving behind eggs that enable them to repeat themselves in a next season, eg. The dubas bug and the cycada; or leaving behind diapausing larvae, eg. the "humeira moth". Other pests may have a continuous occurrence with increased densities at certain times of the year.

The date palm in UAE is targeted by a comparatively large number of arthropod pests: some are serious, difficult to control and threaten the existence of the palm, like the Red Palm Weevil (Rhynchophorus ferrugineus) and the cerambycid stem borer (Jebusaea hammerschmidtii); even therhinocerosbeetleOryctesagamemnon could pose as a life-threatening to the palm. Others are less serious and easier to control; yet there are others which are of no economical importance but they have to be mentioned for the purpose of documentation. There are two species of Buprestid beetles, which I am calling "pests in transit", because they were only seen on the date palm in rare occasions and in the adult stage only. There is an un-identified Tenuipalpid mite which is of very rare occurrence on the date palm and another Tenuipalpid mite [Brevipalpus (=Tenuipalpus) phoenicis] mentioned in the literature as a pest of the date palm, but I have never seen it as such.

These studies which took place in UAE and lasted for more than twenty years also revealed a localized occurrence of a new pest (also a new species to science) ie. The inflorescence beetle Macrocoma sp nov (Coleoptera : Chrysomelidae).

In the presentation the pests are arranged according to insect and mite orders.

The Pests:

A- Pests that weaken the date palm and reduce its crop:

1: The leaf-hopper (dubas bug): Ommatissus lybicus (Homoptera –Topiduchidae):-

This insect has two distinct generations per year; spring and summer, each lasting for about 3 ½ months. At the end of each generation (April-May and October-November) the female lays its eggs inserting them singly into holes it pierces in the tissue of the rachis of the date palm frond. The eggs remain dormant for about 3 months and when they hatch the resulting nymphs continue living on the fronds of the same palm. Both nymphs and adults draw the sap of the palm and excrete copious honeydew which covers the fronds and in heavy infestation the droplets of the honeydew coalesce to give a thin film on the frond on which sooty moulds grow to block the stomata of the pinnae causing partial or complete suffocation to the palm; this will dramatically reduce its crop. The honeydew secreted by the autumn generation drops on the dates making them unpalatable.

The date palm is the only host for this pest.

No biological control is taking place in nature for this insect. Chemical control is essential in most cases, but timing for its operations is very important. It has to be carried out before the nymphs turn into adults or before the adults start laying

their eggs. This differs from place to place; so localized study of the biology of the insect is vital.

Some cultural operations help greatly in preventing the attack in the first place. The most important is the proper spacing of the palms. Well-spaced palms never get infested with this pest.

2: The "Green Scale Insect": (Homoptera – Diaspididae):

This damaging scale insect has been introduced to the Sudan Date Palm farms in the middle of the eighties in some planting material imported from the Gulf region. Because of the absence of its natural enemies in this new habitat it spread in thick population in a large area of densely planted palms causing unsightly havoc, leading among other symptoms to a marked reduction of the produce of the palms.

Breeding of parasitoids and predators to be introduced from its countries of origin is a main factor for control; meantime mineral oils are to be sprayed on the palms during the period(s) of nymph (crawlers) production of the insect – this will help in greatly reducing the population of the insect.

Improved cultural operations and the hygiene of the farms will also help in reducing the damage caused by the pest.

3: The "White Scale Insect" Parlatoria blanchardi : (Homoptera – Diaspididae):-

This is perhaps the oldest and most widespread pest on the date palms; it is found on them where-ever they grow – spreading on the fronds but sometimes it is found on the fruits making them in-edible. The degree of infestation of this pest is markedly variable: it is sometimes thickest on 1-3 palms in a farm whereas other palms do not show any symptoms; even in the affected palm only few fronds are infested. In UAE this pest rarely reached a serious stage; when that happened it was usually concentrated on few of the old fronds of the palm. Cutting of these infested fronds is one of the effective means of control.

There is a good biological control taking place in nature by a number of predators and few parasitoids. No chemical control was ever needed.

4: "The long Scale Insect" Fiorinia phoenicis; (Homoptera – diaspididae):-

This is a new introduction to UAE farms (introduced circa 1984); it rarely reached a serious stage because of some effective natural enemies, particularly a Nitidulid larva and the predatory mite Cydnoseius negevi. No chemical control was ever needed.

5:"The Red Scale Insect" Phoenicococcus marlatti; (Homoptera- Diaspididae):-

A widespread scale insect found on all date palms in every farm, where-ever the date palm grows; but because it is concealed between the overlapping frond bases it is never noticed until deep pruning of the fronds is done. It will then be seen as white powdery material on the surface of the inner base of a frond, with the red scale embedded inside.

No natural enemies can reach this insect in its hideout, but the deep pruning of the palm will expose it to the sun to be killed by its light.

Chemical control is not feasible.

6: The 'giant" mealy bug Pseudasidoproctus hypheniacus (Hall) - (Homoptera – Margarodidae):

This mealy bug is occasionally found on the outside of the bases of the fronds. In UAE it never reached a serious stage and no apparent damage was noticed of its presence. It has a close association of symbiosis with a black ant, the latter usually cleans the bug and its surrounding from its secretions and ward off parasitoids and predators from reaching it.

In the winter these bugs go down to live between the superficial roots of the palm.

An effective method of control is to prevent the ants from climbing the palm to reach the bugs; this will leave the door open to its many natural enemies. There are toxic bands that are put around the base of a tree for this purpose, but they are still under trial to be used for the palm because of the irregularity of its trunk.

Chemical control may be resorted to in the very rare cases of high infestation.

7: The scarlet mite Raoiella indica Hirst (Acari – Tetranychidae):

A minor pest of the date palm; usually seen in groups forming circular patches on either surface of the pinnule: in the middle of a patch are the adult mites, their eggs and nymphs, all in scarlet colour, surrounded by the white coloured exuviae. There is good biological control

on this nymph. No chemical control is needed except in very rare cases of heavy infestation. There are good acaricides to be used.

B- Pests that directly attack and damage the fruits (dates) of the palm

1: The Inflorescence beetle Macrocoma sp. nov. (Coleoptera – Chrysomelidae):

A small beetle of about 5mm in length that I have discovered in one of Fujeira farms in the eighties. It took five years to study its biology and to piece together the different stages of its life cycle.

The adult nibs the small female flowers to completely damage the crop when in big numbers. Its biology is centered in one palm.

An effective method of control is to lightly scratch the top 10 cm of soil in the irrigation basin of the palm that was attacked in the previous season, to remove and kill the larvae. This is done towards the end of the year when larvae would attain a maximum size that makes them easy to spot.

Chemical control is essential for the adults when they attack the female inflorescence. If collection of larvae from the irrigation basin is done satisfactorily, no adults will be seen on the palm in the following flowering season

2: The fruit stalk borer Oryctes elegans (Coleoptera-Scarabaeidae):

A large rhinoceros beetle that sporadically bore into the stalk of the fruit bunch of the palm, causing shriveling of the dates and their complete fall.

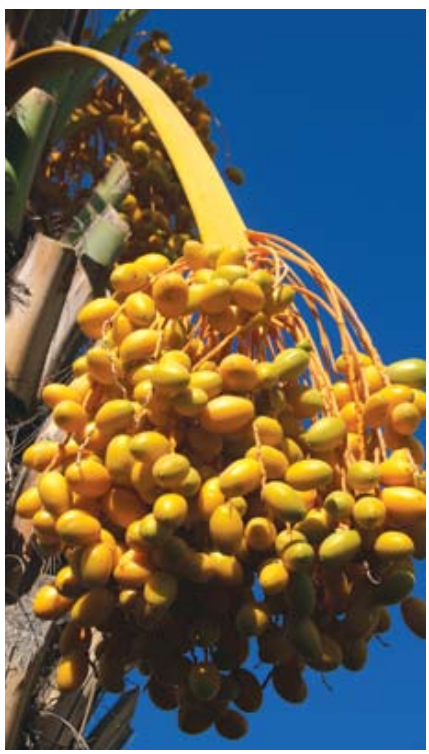
Chemical control is not feasible; all rhinoceros beetles are effectively controlled by light traps and good handling and proper use of organic manures in the farms. All rhinoceros beetles breed in dung heaps and organic manure pits – sometimes they develop on the palm itself, especially on neglected palms not properly pruned or cleaned.

3: The dried fruits beetle Carpophilus dimidiatus (Coleoptera – Nitidulidae):

A small beetle of about 3mm in length; originally a pest of dried stored fruits, but because of neglect in farm hygiene and neglect in collecting and destroying rotting fruits (mainly damaged by fruit flies) on which these beetles breed, this pest has become a regular resident of farms, attacking and destroying ripe dates at the "rutab" stage.

Chemical control is not allowed when the dates are at the rutab stage. Here hygiene of the farm is very important; regular (better daily) removal of rotting fruits (citrus, mango, guava, dates, etc.) should be part of the farm labour force duties.

4: The Dates Moth (Humeira) Batrachedra amydraula Meyr



(Lepidoptera – Cosmopterygidae):

This is one of the most important pests of the date palm, in UAE, that may cause more than 50% loss of the crop if not properly managed. It has three generations a year: the first larvae appear in April to start the damage on the inflorescence and then to the newly formed fruits (dates). The larva eats the inside of the fruit leaving the outer skin intact to dry and to attain a red colour – this is why it is called "humeira". The infested dates, which get detached from their stalks, during the process of the larval feeding, do not fall but remain attached to their stalks by the larval silken threads.

The larva has a period of dormancy that extends from August till March of the next year; spending it wrapped in its silken threads and lying between the bases of the terminal fronds of the date palm. Pupation takes place in March and the adult moths emerge in April – giving more larvae in three overlapping generations which continue to damage the different growth stages of the dates till the pre-last stage ("bisir" stage), then the last larvae go into their annual diapause in the month of August. A larva damages 5-6 dates in its two-weeks of life span.

For the control of this moth (1) removal and destruction of the diapausing larvae as much as possible in a process of

cleaning the fibrous strands around the terminal fronds of the palm.

(2) Chemical control may be carried out on the first sign of appearance of the moth; better still is to spray the chemicals on the crown of the palm that suffered an attack in the previous year as soon as the inflorescence open.

5: The "Inflorescence Moth" Aphomia (=Arenipses) sabella Ham (Lepidoptera – Pyralidae):

This pest used to be a pest of the inflorescence, the attack of the larvae usually starts with the opening of the inflorescence and the larvae feed on the young flowers and their stalks – this is why it is called the "greater inflorescence moth". Lately, it has changed its life-style to a similar manner of the humeira. The larvae of two generations would continue to feed on the dates till the pre-last stage of development of the dates – pupation takes place in cocoons between the terminal fronds of the palm. As it climbs up for pupation the larva feeds on the young terminal fronds.

In UAE the attack, which is of rare occurrence starts after the fruit setting. At a last stage of the moth, the dates bunch is attacked from the inside; the bunch would look normal from the outside. It prefers certain cultivars and was found in very few farms.

The moth is about 20mm in length and the larva is about 22mm in length, dark brown in colour, fast moving and wriggly.

Chemical control of this pest is inevitable.

6: The "oriental Wasp" Vespa orientalis L (Hymenoptera – Vespidae):

This wasp builds its mud nests in the rock cracks of the mountains and is prevalent as a pest of the date palm in the farms of the mountainous east coast of UAE. It attacks, sometimes, in big numbers, the ripe, soft and succulent dates, nibbling bits of them to eat and to take to feed the young in the nests, thus causing plenty of damage to the crop.

Chemical control is not allowed at this stage, but to prevent the attacks of the wasps, farmers now use special nets to cover the date bunches. Destroying the wasp nests is a better option for control, but this is a tedious and perhaps risky operation.

This wasp is also predatory on larvae of some insects.

7: The Tree-hopper Diabolocatantops axillaris (Orthoptera – Acrididae):

This I am calling "tree-hopper" because it only attacks trees; in UAE it is found in very small scattered numbers, but in some rainy years there were severe outbreaks that took place causing damage, killing big mango trees by repeated defoliation and damaging crops of date palms. There was always an associated outbreak of the tree locust Anacridium melanorhodon, causing the same type of damage, but the two species tend to avoid each other; they do not even attack the same farm together.

8: The "Dates Mite" Oligonychus afrasiaticus (Acari – Tetranychidae): -

This mite is one of the important pests of the date palm. It is found, in small numbers, on the fronds of the palm all the year, but when fruiting starts it moves to attack the fruits from their earliest stages of development, spinning a web around the fruits bunch and multiplies in big numbers. Dust collects in the web plus the exuviae of the mite and its different stages of development, which makes the bunch, look dusty – because of this it is also called the "dust mite". It feeds on the juices it sucks from the fruits (dates) rendering them unfit for consumption.

Chemical control of this pest, by the use of acaricides mixed with adjuvants, is inevitable.

C – Pests that attack the trunk and/ or the roots of the Date palm and eventually kill it

1: the Red Palm Weevil Rhynchophorus ferrugineus (Coleoptera Curculionidae):

As is well known, this serious pest is a newcomer to the region. It showed its ugly presence in UAE circa 1985; from then it spread to all other Gulf Region countries and then to Egypt and Jordan, to become a most important pest of the century, a celebrity. Its importance lies in being a fast killer to the palm, unlike the cerambycid trunk borer which is a very slow killer; un-noticed to a layperson.

The adult weevil measures about 40mm in length, with an about 10mm long snout; the male is a little smaller than the female; otherwise there are no morphological differences (dimorphism) between the two sexes, except for a narrow strip of red hairs on the dorsal surface of the male snout (a beard in reverse).

The larva does all the dirty work; it is the trunk borer and damaging stage of the weevil. When the larva is hatched, it starts burrowing on the site of the wound on which the eggs are laid; then it gradually

enters into the palm's trunk, digging upwards intricate tunnels, feeding on the sap for 2-3 months. When it completes development it then directs its tunneling towards the surface of the palm trunk till it reaches a base of a frond; there it collects the fibrous strands to wrap it around itself, building the pupation cocoon; one of the effective methods of control is to remove all the fibrous strands from the palm to deprive the larva from the pleasure of building a cocoon.

Control: there is a number of, methods; no chemicals are involved in any of them:-

(i) : early detection of infestation in a palm and then performing surgery to remove the eroded tissue of the palm at the site of entry of the larvae into the trunk together with all development stages of the weevil, which are mostly larvae, at the site. Aluminium phosphide tablets are placed in the resulting opening, usually at the base of the trunk and then the opening is tightly closed. This is the most important method of control.

(ii) Proper use of the pheromone trap; the traps at present are not properly used and they are doing some damage themselves.

(iii) Control of the rhinoceros beetles, especially Oryctes agamemnon, because they pave the way for the entry of the weevil into the palm trunk.

(iv) Best of all is to prevent the infestation from taking place; here a good extension service is vital, not for this pest but for all pests and for all cultural operations.

2: The longhorn trunk borer Jebusaea hammerschmidtii Coleoptera – Cerambycidae): -

This is the oldest and now the most widespread pest of the date palm;

gaining importance over the red weevil; in UAE it is becoming more important than the celebrity, but because it is a slow killer its occurrence is usually un-noticed until it is too late. It attacks a palm under stress due to neglect or high salinity in the irrigation water.

The infested palm with a riddled trunk due to the boring of the larvae (sometimes there will be more than 500 larvae inside a trunk) and the contamination with saprophytic fungi and bacteria that follow, will remain standing for years until an external force, eg. wind breaks it at midpoint and makes it kneel and then fall.

The larvae bore inside the trunk for nearly a year, pupation takes place inside the trunk, emergence of the adult commences in the month of May till early June. Exit holes of the adult (made by the larva before pupation) are a good sign of an attack.

Control: Beside improving the growing condition of the palm to prevent the infestation, a light trap is the only means of control – it is very effective if properly managed.

3: The trunk and root boring rhinoceros beetle Oryctes Agamemnon (Coleoptera – Scarabaeidae): -

Adults of this large rhinoceros beetle sometimes dig into side shoots of a palm to feed and to hide, thus opening entry wounds for the Red Palm Weevil; the latter is attracted to the smell of the kairomones coming from the opened tissue of the side shoot – a favorite site for the weevil feeding and entry.

Breeding may also take place on the palm itself, particularly on uncleaned and unpruned palms.

The larva is the most injurious stage in the life cycle of this pest; its life span is about 10 months, usually in compost pits and heaps of organic manures stored in the farm without adequate protection. When infested organic manures are added to the irrigation basin of a date palm for fertilization without being examined, the larvae play havoc with the roots - consuming them and then bore inside the trunk, killing the palm.

Due to wrong handling of organic manures in the farms and failure to control the adults, this pest is rapidly gaining importance, approaching that of the red weevil and the trunk borer.

Control: (1) proper handling of organic manures in the farm. (2) use of light traps regularly from sunset to dawn daily during the summer months (in UAE; April – October) only.

* Entomologist; formerly Expert of the Arab Organization for the Development of Agriculture on secondment to UAE Ministry of Agriculture & Fisheries.

D: Pests in transit:

This name I am giving to pests seen in UAE on the date palm once during the twenty years of study and in the adult form only. That is a species of what are called the "flat head beetles": Julodis fimbriata (Coleoptera – Buprestidae). A large ornate beetle seen suddenly in big numbers in a farm in the eastern coast of UAE; adults gnawing pinnae of the fronds of the palms and causing damage. After a few days from the discovery of their presence they disappeared, not to be seen again.

Another species of the same genus: Julodis caillaudi is mentioned in the literature as a minor pest of the date palm in Sudan.

Discussion on the control of the Arthropod Pests of the Date Palm:-

Successful control of the pests of the date palm – or any other pests- depends on a good agricultural extension service; the farmer has to be made aware of all new developments in the cultural operations one at a time as they come. The farmer until now believes in the use of pesticides as the only saviours for his problems in his farm, even on physiological changes that might occasionally happen to his plants. It is the duty of extension officers to make him aware of other safe and more effective alternatives.

As seen in this brief account for "The pests of the date palm" and as will be seen in the "presentation", very little mention was made for chemical pesticides, not only of the toxicity of the pesticides but because there are better and more effective alternatives.

The right spacing of planting the date palm, the hygiene of the farm, the hygiene of the date palm itself, the proper handling of organic manures in the farm, are all important factors for good farm management. More important is the proper use and respect of the traps; whether pheromone traps or light traps.

The aggregation pheromone trap for the Red Palm Weevil has been in successful use in UAE since 1993 and until now it is not finding the respect it deserves from the farmer; this also goes for the light trap. The farmers are not convinced of their importance, and the farm labour forces are pleased with that because these traps have not become part of their daily tasks; they deal with them as they please.

So what IPM can we expect?

To me, and because of the importance of mass-trapping for the control of the most important pests of the date palm, the only answer is the use of communal traps (pheromone and light) to be run by official agricultural establishments or by tendered private establishments. They do not need to be placed inside farms; they may be located, somehow, at farm road junctions and looked after by a labour force to be recruited for this purpose only. That will be much cheaper to run and much more effective than what is being done at present.

Dr. Hegazy ,G.

Ain Shams Univ. Fac. of Agriculture.
Plant Protection Department
Cairo, Egypt.

Dr. Salem ,M. A.
Dr. O. AL-Mohanna

Date Palm Research
Center,Alhasa,Kingdum of Saudi Arabia

Arab Organization for Agricultural Development Project of transfer of biological control technology to integrated pest management of the red palm weevil in the Middle East.

Ecological and Biocontrol Studies on the Red Palm Weevil

Rhynchophorus ferrugineus the Main Insect Pest of Date Palm Trees in the Arabian Gulf Region

Key words: Rhynchophorus ferrugineus. Red palm weevil. Entovmopathogenic control. Beaveria bassiana. Metarhizium anisopliae . Date palm trees.

Abstract

The present study was conducted at Al-Qatif region in the Kingdom of Saudi Arabia through a program of the Arab Organization of Agricultural Development.

The population density of the red palm weevil, Rhynchophorus ferrungineus was surveyed in two years 2000 and 2006 to determine the weevil abundance during the 12 months of those years. In both considered years, two major peaks were detected, a higher peak was observed in the middle of June, which was higher in the year 2000 than that in 2006, i.e. a mean of 15.52 and 11.44 weevils/ trap, respectively. A lower second peak occurred in October and November in 2000 and 2006, respectively. The lowest population density of weevils was recorded in the winter months starting from December up to February.

Susceptibility of date palm tree varieties exhibited different degrees of infestation by the red palm weevil; a high infestation percentage ranging between 23.8 and 27.3 % was observed in Azaba Banat, Reziz and Hagab. The varieties Fahel, Bekera, Halow Ahmer, Awinate, Shehl and Kesba were moderately infested (ranging between 10 and 17.5 %). The varieties Goara,

Kenezi and Magi exhibited approximately

Photo 2. Emergence of Beauveria bassiana on red palm weevil larvae after spraying

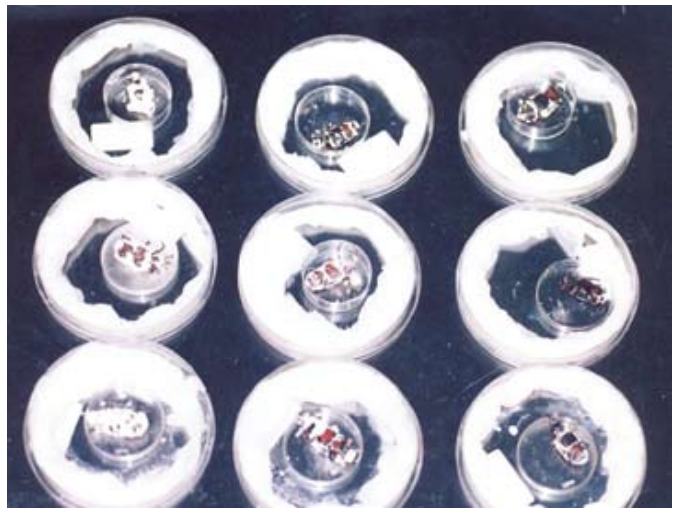


Photo 1. Emergence of Beauveria bassiana on red palm weevil

a 10% infestation percentage; meanwhile, Nashwo was quite resistant to infestation by the red palm weevil.

Furthermore, rate of infestation by the red palm weevil differed on the date palm tree trunk, at a height of 50 cm above ground level, the highest percentage of infestation was detected (i.e. 40%). This was followed by a 20% infestation at ground level, while minimal percentage of 7% was found at the height above 1 meter on the tree trunk from ground level.

Two new Saudi Arabia isolates of the entomophathogenic fungi Beauvaria bassiana (BSA 3 Saudi isolate) and Metarhizium anisopliae

were successfully isolated and recorded, both of which were mass cultured in the laboratory on a Sabouraud plus yeast extract medium and a solid rice grain

medium. A bioassay was conducted to determine the efficiency these two Saudi isolates B.bassiana and M.anisopliae prepared as fungi-codacide oil suspension. In the laboratory experiment, according to the calculated $LT_{50,}$ M.anisopliae proved more effective than B.bassiana as it depicted a shorter LT_{50}. Under semi field B.bassiana proved to be more effective than M.anisopliae as LT_{50} was 121.89 and 132.7 hours, respectively.

In a field experiment, B.bassiana fungi-codacide oil suspension was sprayed at a concentration of $5x10^8$ conidia/ ml on infested date palm trees. One month following the first spraying in December the number of weevils was reduced from 16.5 to 6 weevils/ trap giving a reduction of 63.64%. Meanwhile, following the second application of this fungi suspension in April, low of only 9.09% reduction in the insect population.

Introduction

The red palm weevil Rhynchophorus ferrugineus (Coleoptera: Curculionidae), is a most destructive pest to palm trees in many countries. This weevil attacks coconut, oil and date palms throughout South East Asia (Kalsohven, 1950). The red palm weevil was accidentally introduced for the first time in the Arabian Gulf region in 1985 in the United Arab Emirates, then in 1986 it appeared in Saudi Arabia. In 1992, it spread to Iran, followed by Egypt in 1993, Jordan and occupied Palestine in 1998 and 1999 respectively (Abraham et al., 1998; Murphy and Briscoe, 1999 and Soroker, et al. 2005). In 1997, the Arab Organization for Agricultural Development (AOAD) based in Sudan set up a project with the aim of controlling this destructive insect pest . Efforts for control of R. ferrugineus were focused on the use of traditional chemical insecticides or by eliminating infested trees. Control of this pest is now more concerned with the use of entomopathogenes of which the fungi Beauveria bassiana and Metarhizium anisopliae proved to be most effective. These two fungi have been reported to be successful in the control of several coleopteron insects, a survey conducted by Li (1988) showed 200 species of coleopteron and lepidopteron insects were infected by these fungi. Subsequently, successful control of many insect pest have been reported by the use of these entomopathogenic fungi; e.g. potato beetle, Leptinotarsa decemlineata (Miranpuri et al., 1992a); flea beetles, Phyllotreta crucifera (Miranpuri et al. ,1992b); blister beetle, Lytta nuttali

Photo 3. Discovering the isolation of Emergence of Beauveria bassiana in Kingdom of Saudi Arabia in the soil under the date palm farms

Photo 4. Impact of the discovered Beauveria bassiana on red palm weevil

(Miranpuri and Khachatourians, 1994), and banana weevil (Nagra et al., 2004).

The present investigation was undertaken was carried on date palm trees in Al-Qatif Region, Saudi Arabia by a project sponsored by AOAD. The experiments were concerned with the following:-

1- Survey of the seasonal fluctuation in the population densities of the red palm weevil. This part of the work is significant for choosing the appropriate time for control of this insect pest.

2- Susceptibility of the different varieties of date palm tree to infestation by the red palm weevil.

3- Infestation by the red palm weevil on the vertical height of the date palm tree trunk as well as the age of the trees.

Photo 5. Employee training on proliferation of the pathogenic fungi (Beauveria bassiana) to insects on environment of Sapurad Dexter's Agar

4- Evaluating the efficiency of two new entomopathogenic fungi isolates Beauveria bassiana (BSA3) and Metarhizium anisopliae (Saudi isolate) under semi field condition for the control of the red palm weevil.

5- Efficiency of B. bassiana (BSA3) for the control of red palm weevil in the field. It was necessary to establish means for the mass production of these fungi in the laboratory so as to supply sufficient amounts needed for experiment.

Materials and Methods

Experiment 1: For the collection of the red palm weevils from infested date palm trees an improved insecticide free food baited aggregation pheromone / kairomone traps were used (Hanounik et al., 2000) and approved by the project AOAD. These traps were placed partially buried around the trunk of the date palm trees at the plantations in Al-Qatif region. Approximately 12 traps were placed (one trap/ hectare), the traps were investigated at a weekly interval throughout the year, the number of collected weevils were recorded and mean number of weevil/ month determined. It was noteworthy, that the traps were replaced with fresh ones at each weekly inspection.

Photo 6. Installment of Pheromone-kairomone trap that was used to collect red palm weevil from date palm farms

Photo 7. Search for red palm weevil under date palm trees after 48 hours from spraying, then put them into incubation under humidity conditions to know cause of death (See Photo 1)

Experiment 2: It is well established that all date palm tree varieties are liable to infestation by the red palm weevil. However, liability of infestation was noticed to be higher in some varieties and lower in others, also, the age of the palm tree showed some variation. A total of 3017 date palm trees presenting 16 varieties were considered in this part of the work in Al-Qatif region. The palm trees were divided into two groups, the first presented wide spread popular varieties ,e.g. Reziz, Shishni, Klas, Fahl, Bekera, Hellaw Ahmer, Goarra , Kinizi and Nashow .The second group was expressed by less common varieties e.g. Asaba Banat, Hogob, Awinate, Shehl , Kesba and Magi . Other varieties presented by 15 or less palm trees were not considered in this survey.

Photo 8. Spraying Date Palm farms with the fungi's solution product (Beauveria bassiana)

Experiment 3: The vertical distribution of infestation by the red palm weevil on the trunk of date palm trees was also studied. The distance (cm) between symptom of infestation on the trunk at ground level and different heights of the palm tree was measured as well as under the soil. In this investigation only signs of fresh infestations were considered.

Furthermore, approximately 200 trees regardless of their variety were categorized according to their ages; 1-5, 6-10, 11-15, 16-20, 21-25, 26-30 and 31-40 year old tree, and rate of their infestation by the red palm weevil determined.

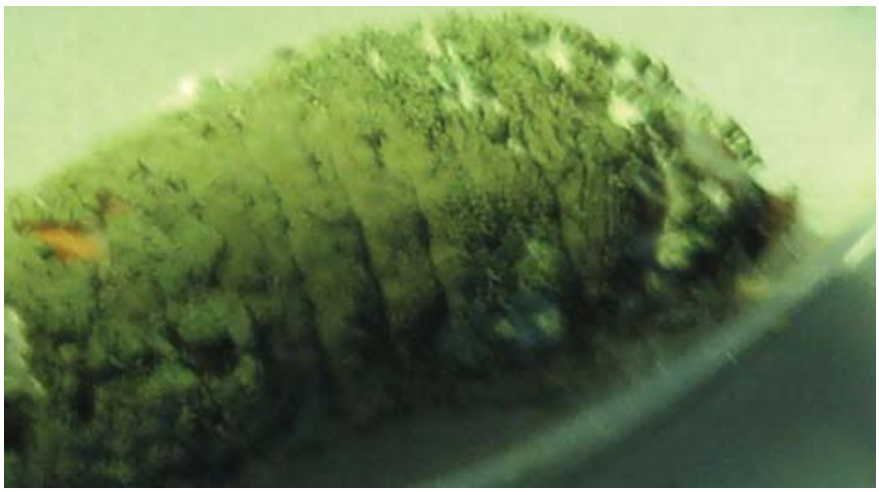
Photo 9. Half-circled Experiments boxes before spraying the farms

improved insecticide free food baited aggregation pheromone - kairomone traps were used

Experiment 4: Two new Saudi Arabia isolates of entomopathogenic fungi were evaluated for their efficiency in the control of the red palm weevil, (i) Beauveria bassiana (BSA3 Saudi isolate), Hegazy et al. (2007) working at

AOAD project successfully isolated this fungus from infested red palm weevils collected at Al-Qatif region, it was recorded after being verified by CABI Bioscience, UK.

(ii) Metarhizium anisopliae was isolated by Hegazy and Al –Muhanna (2006), from the soil under date palm trees at Al-Qatif region .This fungus was confirmed by Biological Control Institute, at Dermchtate, Germany. These two entomopathogenic fungi were mass produced in the laboratory of the AOAD project at Al-Qatif region.



Larvae of Rhynchophorus ferrugineus sprayed with entomompathogenic fungus Metarhizium anisopliae

For the production of the two fungi a liquid Sabouraud Broth plus yeast extract medium (per litre: Mycological Peptone 10gm, Dextrose 40 gm, yeast extract 2.5 gm) was prepared and 60 ml of the medium is then distributed into 250 ml Erlenmeyer flasks.. The flasks were plugged with cotton bungs, covered with aluminium foil and autoclaved at 121°C for 20 min. Once cool, each flask was inoculated with 1 ml of a spore suspension (6×10^6 conidia/ml) in 0.05% Tween 80 using fresh conidia obtained from SDYA slopes. The flasks containing inoculated media were placed on a rotary shaker (110 rpm) for 3 days at 27± 2° C. This procedure provides an inoculum of suspended mycelial fragments in active growth phase for transfer onto the solid substrate. The mycelial inoculum was diluted by 50% with cold sterile water before transfer to the solid substrate (Jenkins et al., 1998).

A solid medium made with rice grains was also tested for the mass production of the considered fungi according to the method of Jenkins et al. (1998). From a preliminary experiment the Egyptian variety of rice proved to be more efficient than the American rice Uncle Ben for the

maintenance of the fungi (Hegazy and Al-Muhanna, 2006). Rice grains were washed in running water for 10 minutes then well drained, fresh water was then added to the rice at the rate of 300 and 200 ml/ kg for that to be inoculated with B. bassiana and M. anisopliae, respectively. The rice was par boiled for 10 min to accelerate the absorption of the water before distributed into autoclaveable sacs (1 kg dry rice/ sac) and autoclaved for 60 min at 121^{0}C. Once cool, the bags were transferred to a laminar air flow cabinet and 150 ml of ready diluted liquid inoculum was added to each sack and thoroughly mixed. The sacs were blown by sterile oxygen and sealed then placed on

shelves in a disinfected air conditioned room at 27 ± 2° C for 15 days. On completion of the incubation period the sacs were opened and the inoculated rice was spread at a 3 cm layer thickness on disinfected plates to allow the substrate to dry. The conidia were observed to form a white layer on the surface of the conidiated rice and by means of a sieve it was separated and collected as a dry powder. This powder was placed in disinfected plastic sacs with non indicating silica gel at a rate of 20% w/w .The sacs were sealed and stored at -4°C until needed for the experimental work.

The fungi B. bassiana and M. anisopliae are hydrophobic and do not form a suspension in water, therefore Codacide oil was added to the dry conidia to overcome this issue. Codacide is a natural vegetable oil adjuvant produced by Dow Agro Sciences which when mixed with plant protection pesticide (e.g. herbicide, fungicide insecticide, IGR…etc) increase their efficiency by improving their deposition, spread and reduces spray drift. Also, it improves deposition adhesion on plant surface or insect cuticle. Therefore, the addition of codacide to the prepared B. bassiana and M. anisopliae spray formulation was evaluated to establish if its addition would

Mass production of entomopathogenic fungus Metarhizium anisopliae on rice

improve the characteristic of the tested entomopathogenic fungi. Suspensions of 5x10^8 and 5x10^9 conidia /ml of either M .anisopliae or B.bassiana, were added to 10 cm of codacide oil in one liter distilled water and blended well on an electric rotator. It is noteworthy, that these two concentrations were chosen from the bioassay conducted by Hegazy et al. (2007) to determine the fungi LC_{50}.

Mass production of inoculated rice by entomompathogenic fungus B. bassiana (BSA isolate)

To establish the homogeneity in distributions of the fungi-conidia suspension, it was sprayed on glass slides and the droplets were investigated by a microscope. The viability of the fungi was then determined by cutting off the antennae of treated weevil and fixing it on the inner side cover of SDA Petri dish and inoculation of the fungus was followed.

Experiment 5:- A laboratory experiment was conducted to determine LT_{50} (mean lethal time) from the accumulative mortality of the red palm weevil treated with the concentration of 5x10^8 and 5x10^{9}conidia/ml of both B.bassiana and M.anisopliae fungi-conidia suspension. Results were presented graphically as log/probit lines and LT_{50} values calculated by the program Sigma plots for windows (version 2).

Experiment 6:- A semi field experiment was carried out in a date palm nursery, uninfested young shoots were chosen, each of which was covered

by a mesh netting. To each shoot ten adult red palm weevils were introduced, they were left for 24 hours to assure their boring in the tree trunks. Subsequently,

Mycosis of treated R. ferrugineus sprayed with

Semi field application of entomompathogenic fungi on red palm weevils

six plots, each presented by ten date palm shoot (still enclosed in the mesh net) were considered. The first and second plots were sprayed with $5x10^8$ and $5x10^9$ conidia/ml, respectively, of B.bassiana fungi-codacide suspension. The same procedure in the third and fourth plots was sprayed with M.anisopliae at the respective above mentioned concentrations. As a control, date palm shoots were sprayed with water and another control was sprayed with water mixed with codacide oil. Mortality of the weevils was calculated from which the lethal time LT_{50} determined.

Experiment 7 :- Field application of the fungus B. bassiana (BSA3):

Two adjacent date palm trees farms, each of approximately 5 hectares infested by the red palm weevil were selected, one presenting a control and the other specified for the spray application of the entomopathogenic fungus B. bassiana Saudi Arabia isolate (BSA3). One month prior to the application of the fungus B. bassiana at a concentration of $5x10^8$ conidia/ml the mean monthly population density of the red palm weevils was determined from the weekly catch by the pheromone/ kairomone traps; the traps were distributed at a distance of 100 meters apart. In the experimental farm, date palm trees were sprayed by means of 600L mechanical sprayer with $5x10^8$ conidia/ml of B.bassiana obtained from the maintained mass culture. The nozzle of the sprayer was modified to give a slow coarse spray and spraying of the fungus suspension was directed to the crown of the tree where weevils are known to aggregate. Two applications, with the same concentration, were administered to each palm tree, the first application was conducted in December 2005 and the second in April 2006. Following each application of the fungus the mean monthly population density of the red palm weevil was again determined by the use of the pheromone/ kairomone traps, so as to evaluate the efficiency of the fungus spraying in reducing the population of this weevil.

The same procedure of the above mentioned experiment was repeated in the year 2007; however, the first spraying of the fungi suspension was carried out in February and the second in April. The numbers of weekly caught weevils were counted and the monthly mean number of the caught insects determined.

Percentage reduction in the numbers of the red palm weevil was calculated by Henderson and Tilton equation (Henderson and Tilton, 1955).

$$R = \left[1 - \frac{Ta \ x \ Cb}{Tb \ x \ Ca} \right] x \ 100$$

Where:

R = Percentage of population reduction

Tb = Number of insects in treated plot before treatment.

Ta = Number of insects in treated plot following treatment.

Cb = Number of insects in control plot before treatment.

Ca = Number of insects in control plot following treatment.

This experiment was important so as to determine the appropriate time of the year for the control of this insect pest. It was necessary to determine if the death of the weevil was due to infection by the fungus or other reason. For this purpose, the caught weevils as well as any dead ones found on the trees or soil were also picked and taken to the laboratory

for investigation. These weevils were individually placed in humid Petri dishes, after seven days the insects were investigated to determine mycosis on their cadavers.

Results

Population densities of the red palm weevil R. ferrugineus

In the survey conducted during the two years 2000 and 2006, it was noticed that the mean monthly abundance of the red palm weevil fluctuated during the different months. Furthermore, both years understudy exhibited a similar trend and also at a much lower abundance in the year 2006. In both years under investigation the highest number of insects on the palm trees was detected during the month of June.

As depicted in Fig.1, in the year 2000 a gradual slow rate of increase in the abundance of weevil started from the beginning of January up to the middle of April. This was followed by a sharp increase to reach a peak in the weevil population by the middle of June reaching a mean of 15.52 weevil/ trap/ month. In the subsequent months, the insect's population sharply decreases to reach a mean of 6.32 weevil/ trap/month in September. Subsequently, a second peak in the insect's population was observed in the middle of October giving 8.8 weevil/ trap/month. The number of collected insects then slowly gradually declines up to the end of December, (i.e. 5.6 weevils/ trap/ month).

In the second year, 2006, under investigation, a relatively similar trend to that observed in 2000 in regard the number of red palm weevils collected by the traps, although at a lower rate. In this year a sharp drop in the number of weevils occurred from 7.72 to 2.88 weevil/ trap/ month from January to February. This was followed by a slow gradual increase to reach a first peak of 11.44 weevil/ trap/month in middle of June which then dropped between to 3.6 to 3.12 weevil/ trap/month in September and October 2006, respectively. A second peak was detected in the middle of November reaching 9.64 weevil/ trap/ month followed by a sharp decrease of 5.6 weevils / trap/month in December.

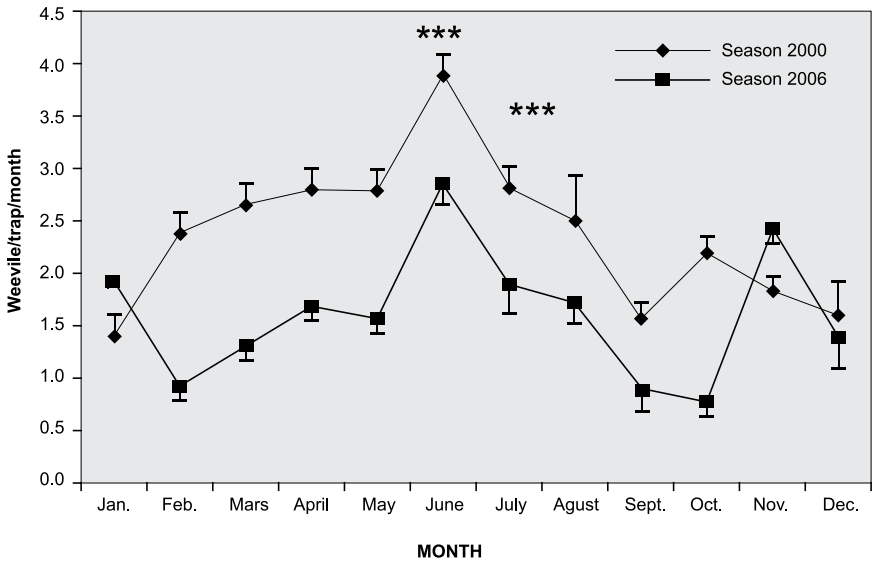


Fig. 1: Monthly fluctuation in the population density of the red palm weevil at Al-Qatif province, Saudi Arabia in two different years 2000 and 2006.

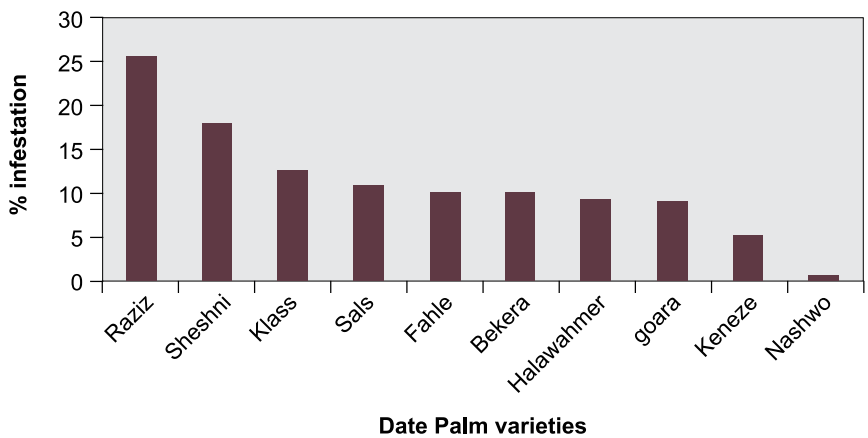


Fig :2.Percentage infestation by R. ferrugineus on popular wide spread date palm tree varieties.

Susceptibility of date palm varieties to infestation by the red palm weevil Rhynchophorus ferrugineus

In the popular wide spread varieties, Reziz was the most susceptible date palm variety to infestation by red palm weevil reaching 25.9 %, this was followed by 17.9 % in Shishni variety In the varieties Klas ,Sals ,Fahl, Bekera, Hallow ahmer and Goarra the rate infestation was much lower and ranged between 9 to 12.5%.

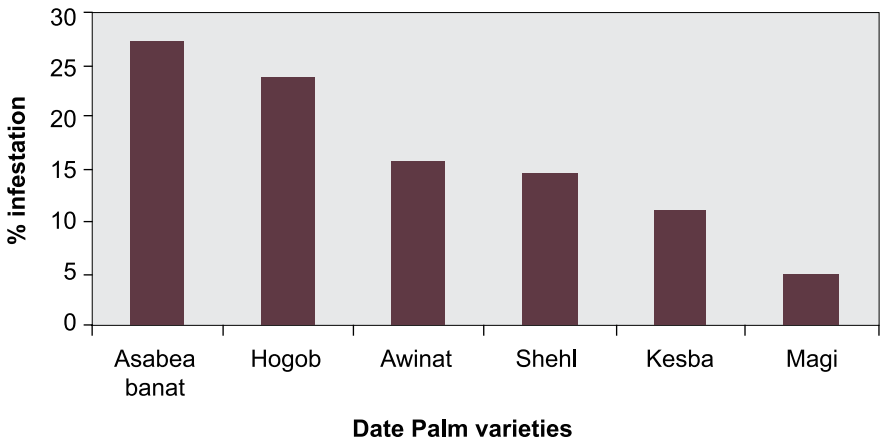


Fig 3.Percentage infestation by R.ferrugineus on less common wide spread date palm varieties.

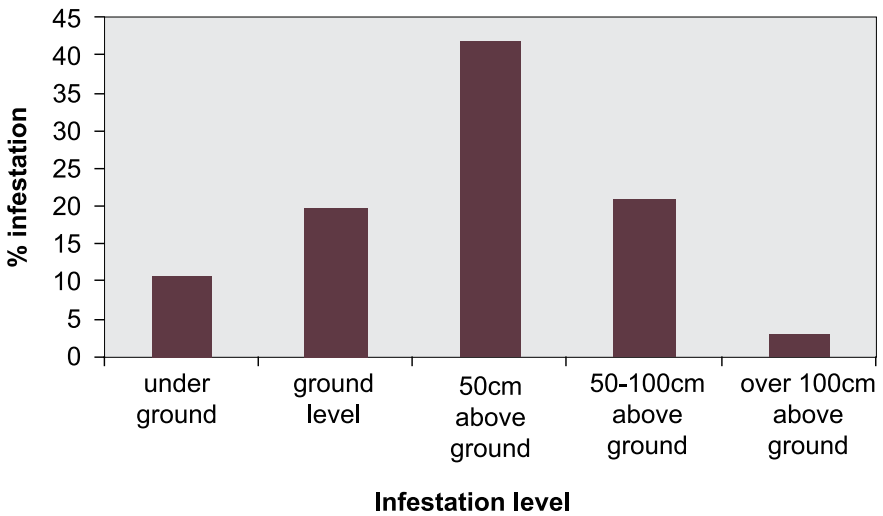


Fig.4: Vertical distribution of infestation by the red palm weevil on date palm tree trunk

The least infestation was detected in Kinizi and Nashow varieties, i.e. 5.1 and 0.5 % respectively (Fig. 2).

In the less popular varieties, the variety Asaba Banat was the most susceptible to infestation by the red palm weevil giving 27.3% closely followed by Hogob (23.8 %).The ratio of the infestation in Awinate, Shehl and Kesba varieties were 15.0, 14, 6 and 11.1% respectively. In this group the least ratio of infestation of 4.8% was recorded on Magi variety (Fig. 3).

Vertical distribution of infestation:

From a survey conducted on nearly 200 date palm trees infested by the red palm weevil and ranging in age between 1 to 10 years, it was observed that 11 % of weevil infestation was below soil level. Meanwhile, a higher level of infestation reaching 20 to 21% occurred on the tree trunk at ground level

and between 50 to 100 cm height. The highest infestation percentage of 40% was detected at the height of 50cm on the tree trunk from ground surface. Meanwhile, minimal infestation of 7% was found above 100 cm level (Fig.4).

The highest percentage of 2.75% infestation by R.ferrugineus was detected on date palm trees ranging in age between 6 and 10 years, this was followed by 1.1% in those aged 11and 15 years. Younger date palm trees i.e. 1 to 5 years exhibited 0.4 % infestation by the weevil. It is noteworthy, that weevil infestation in older trees (above 16 years old) was minimal.

Efficacy of the entomopathogenic fungi B.bassiana and M. anisopliae for the control of the red palm weevil:

(i)Fungi–codacide suspension: It was necessary to determine the distribution of the sprayed fungi-codacide suspension. Using an atomizer, the fungi suspension mixed with 10% codacide oil was sprayed on a glass sheet. Observation with a microscope exhibited an even distribution of the conidia of both B.bassiana and M. anisopliae as they appeared as a homogenous layer with no cells clumping or clusters.

To examine the viability of the fungi-codacide suspension, red palm weevils were sprayed with 5x 10^8 conidia /ml, subsequently, the antenna of the weevils were severed and fixed on the inner surface of a SDA Petri dish. After approximately 7days, the antennae were investigated, in all cases, the fungi was evident on these antenna and the grown conidia had dispersed on the SDA medium and subsequently grew normally as colony forming unit proving the viability of the fungi-codacide suspension.

(ii)Laboratory experiment: Two concentrations, 5x10^8 and 5x10^9conidia /ml of each of the two fungi-codacide suspensions B. bassiana and M. anisopliae were tested to determine their LT_{50} under laboratory conditions (Table 1 and Fig.5). When the higher concentration, i.e. 5x10^9 conidia /ml of B. bassiana or M. anisopliae

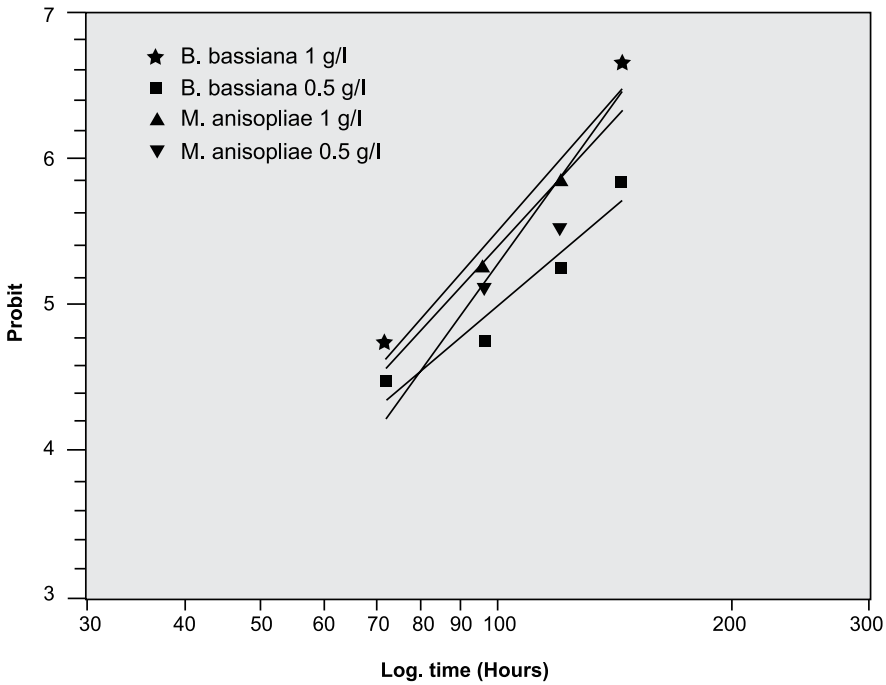


Fig. 5: LT_{50} calculated from accumulative mortality of the red palm weevil treated by two concentrations of B. bassiana and M. anisolpiae spores under laboratory conditions.

Fungi	Concentration	LT_{50} (hours)	Slope	r
B. bassiana	$5x10^9$	91.20	7.39	0.95
	$5x10^8$	100.44	4.48	0.96
M. anisopliae	$5x10^9$	82.79	6.15	0.97
	$5x10^8$	85.11	5.86	0.93

Table 1: LT_{50} values of the red palm weevil treated by two concentrations of B. bassiana and M. anisopliae under laboratory conditions.

were tested, LT_{50} was found to be 91.20 and 82.79 hours, respectively. When the lower concentration of the respective mentioned fungi was applied, i.e. $5x10^8$ conidia /ml, the calculated LT_{50} were slightly longer i.e. 100.44 and 85.11 hours, respectively. These values show that M. anisopliae had a more rapid effect than B.bassiana in the laboratory experiment. The regression values estimated from the regression lines ranged between 0.93 and 0.97.

Semi field experiment: Table 2 and Fig. 6 show the values of the calculated LT_{50} of the red palm weevil following treatment with the two fungi under

study conducted under semi field conditions. LT_{50} was 121.89 and 132.70 hours for B. bassiana and M. anisopliae, respectively, in addition, the slope values of the probit regression lines were 3.23 and 2.72 while the regression values were 0.98 and 0.97 to the two respective mentioned fungi. These values show that under semi field conditions B. bassiana exhibited a higher potency and a more rapid action than M.anisopliae against this weevil. In addition, according to the fungi conidia it was observed that the dimension of B. bassiana spores was 3.5 micron. Meanwhile, M. anisopliae spores were elongated with a dimension of 9 micron, signifying that B. bassiana spores exhibited a more surface area contact than that offered by M. anisopliae spores which may in turn may affect the potency of the fungi.

(vi)Field application in the season 2005-2006:

Prior to the application the fungus B. bassiana on date palm trees infested by the red palm weevil, a mean of 16.5 weevil/ trap/month were caught by the pheromone/kairomone traps (Fig.7). After the first spraying in December 2005 by this fungus at a concentration of $5x10^8$ conidia/ml, the monthly mean number of collected weevils after one month following application was reduced to 6 weevil/ trap giving a total 63.64% percentage reduction in their population. Prior to the second application in April 2006 by B.bassiana, 11 weevils/ trap were collected, after one month from this application, the population of the weevils was reduced by only 9.09%, (Fig7).

Dead R. ferrugineus weevils collected from the field following the first application of B. bassiana, showed that 88% of these collected weevils died as a result of their infection by this fungus .This was exhibited by the mycosis on weevil cadavers.

The previous experiment was repeated in 2007 but by applying the first spray treatment by $5x10^8$ conidia /ml of B.bassiana in the second week of February instead of December and the second application during the second week of April. The number of collected weevils

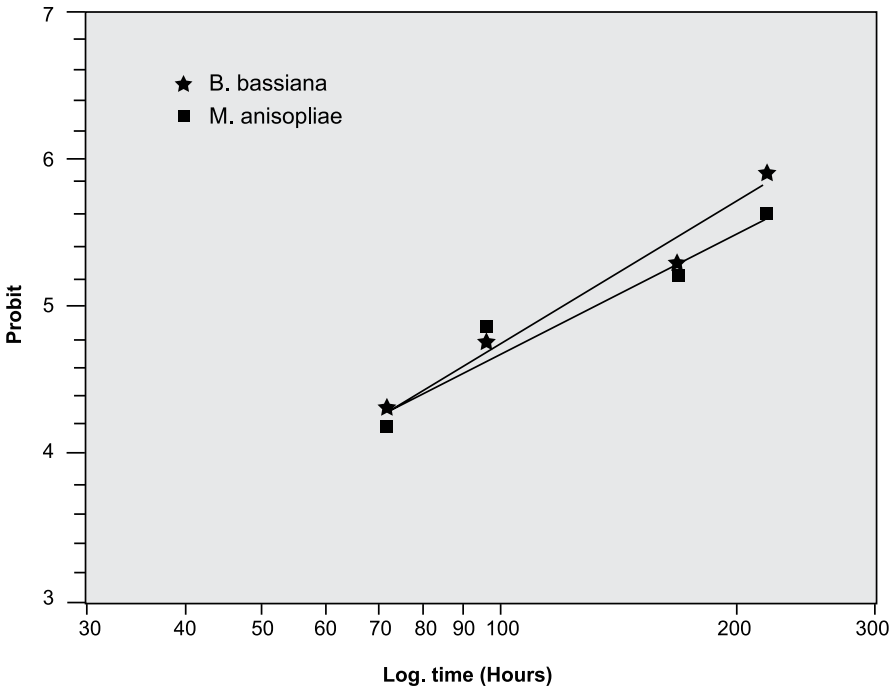


Fig. 6: LT_{50} calculated from the accumulative mortality of the red palm weevil treated by B.bassiana and M.anisopliae at $5x10^8$ conidia /ml under semi field conditions.

Fungi	LT_{50} (hours)	Slope	r
B. bassiana	121.89	3.23	0.98
M. anisopliae	132.70	2.72	0.97

Table 2: LT_{50} values of the red palm weevil treated with $5x10^8$ conidia/ ml of B. bassiana and M. anisopliae under semi field conditions.

prior to the first application was 8 weevils/ trap. One week following the fungus spraying the number of collected insects was markedly reduced to 3 weevils/ trap, with no change in the weevil population in the control, giving a 70% reduction in the population of the red palm weevil. However, in the second week following the fungi spraying the number of trapped weevils in the treated plot had risen to 10 weevils/ trap, comparable to their number detected in the control plot (i.e. 11 weevils/ trap). At this period percentage reduction in the insect population was only a low of 9.09%. A mean reduction of 38.1% in the weevil population was calculated in these two week period in February.

In the second week of April, the population of R.ferrugineus in the control plot was 8 weevils /trap, however this number increased to 13 weevils /trap in the third week of this month. Meanwhile, in the plot treated with B.bassiana there was a reduction in the population of the red palm weevil from 12 to 8 weevils/ trap.

Discussion

The Saudi Arabia isolates of the two entomopathogenic fungi B.bassiana and M. anisopliae were successfully cultured in the laboratory on the standard semi liquid medium prepared from dextrose and peptone. Also, a solid medium prepared from rice grains was tested and proved its high efficiency in producing a high yield. The component of the latter medium was much more economical than the former one, therefore, it should be more suitable for the mass production of these two entomopathological fungi. Godonou (1999) working with a rice medium achieved $5x10^5$ conidia per gram of B.bassiana.

In the laboratory test, M.anisopliae had a much more rapid effect on the red palm weevil than B.bassianna as exhibited by LT_{50} values. Meanwhile, when the same test was conducted under semi field conditions, B.bassiana was much more potent as a lower LT_{50} value was observed. This signifies that the potency of M.anisopliae in the field was more affected by some environmental factor to which B.bassiana was much more tolerant.

Codacide oil was added to the two prepared suspension of both fungi to increase their efficiency. Bateman et al. (1998) and Luze and Batagin (2005), indicated that the use of oil enhanced the efficiency of

mycoinsecticide, furthermore, the addition of oil enables fungi pathogens to remain active under conditions of low humidity.

Before implicating any control program, it is necessary to determine the population of the insect so as to choose the appropriate time for the application of control measures. El-Garhy (1996) conducted experiments in Egypt and found that population of the red palm

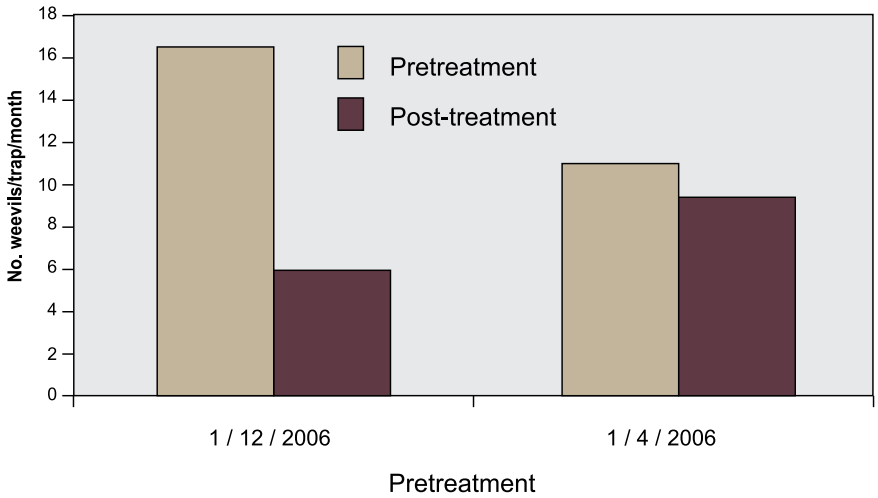


Fig.7: Numbers of R.ferrugineus weevils prior and post treatment with $5x10^8$ conidia/ ml B.bassiana (BSA3) on date palm trees at Al-Qatif region.

weevil increased with the onset of warmer weather, starting from the month of April. Meanwhile, also in Egypt, Hussein (1998) stated that environmental changes do not appear to have any remarkable influence on the population growth of the red palm weevil. In the present survey conducted in Al-Qatif (KSA), it was observed that the highest population density of the red palm weevil was detected in June and in October-November; meanwhile relatively low infestation was found in December up to February. This shows that this weevil can tolerate warm and moderate high temperatures more than their toleration to lower temperatures. Meanwhile, the weevil's population declined with the high temperatures in the months of July, August and September. It seems reasonable to assume that as only adult weevils were considered in the trapping, it could be suggested that development of this insect in the larval stage could have been extended in the cooler months of the year, and therefore delayed the appearance of the adult weevil. Or that due to rise in temperatures, the insect life span was shortened and adult weevils emerged in search of their mates. However, further studies are needed to establish the life cycle of this insect in the field.

Choosing the appropriate time to conduct a biological control program by the use of fungi is most important for it to succeed. The potency of fungus B.bassiana sprayed in the field, apparently, was affected by several environmental factors. It was found most efficient in reducing the population of the weevils in the first and second week following application, subsequently; the fungus gradually loses its viability. Bernal et al. (1999) found that infection levels of B.bassiana and M.anisopliae were highest during the first five days following application. Costa et al. (2001), found that the persistence of viable B.bassiana spores was significantly longer when a greater portion of the UV spectrum was blocked. Hegazy et al. (2007) showed that germination of B.bassiana conidia was more affected by sunlight than temperature.

Most date palm tree varieties were infested by the red palm weevil but by different rates. This observation is most significant; therefore, relatively resistant varieties are to be chosen when planting new fields, without neglecting the yield and economical value of the date palm varieties. Infestation by the red palm weevil was relatively low in young trees (1 to 5 year old), older ones (6 to 10 year old trees) were liable to a higher rate of infestation. Meanwhile, in 16 and older trees negligible infestation was detected. These observations may signify the preference of the red palm weevil to certain nutritional factors found in some palm tree varieties and not in others; also the penetration of this weevil in the trunk of old trees might be hindered to certain

Treat ment	N° of insects		% Reduc tion	Number of insects after 2 weeks	% Reduc tion	Mean number of insects	% Reduc tion
	Before treat ment	After 1 week					
Control	8	10	------	11	------	10.5	-----
Treated	8	3	70	10	9.091	6.5	38.1

Table 3: Number of Rhynchophorus ferrugineus weevils caught by in date palm tree plantation treated with Beauveria bassiana (BSA 3)

factors in the tree structure.

The two considered entomopathogenic fungi B.bassiana and M. anisopliae proved their efficiency in the control of the red palm weevil, therefore should be included in an integrated pest management program.

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Endoscope: A potential diagnostic tool for Red Palm Weevil infection

Hamad Saad Al-Saad
& El Fatih Mohamed Mahdi

Plant Tissue Culture Laboratory
Department of agriculture and Water Research
Ministry of Municipal Affairs and Agriculture
Qatar

Abstract

Red palm weevil is becoming a serious pest of date palm in Arabian Gulf countries, Egypt, Iran, Jordan and Palestine, where infestation rate is relatively high. Voluminous endeavors were pursued in pest control. Yet, detection and monitoring of infection is still based on visual symptoms. The present paper introduces endoscopy as e new reliable method for detection various stages of infection.

Introduction

Red palm weevil (Rhynchophorus ferrugineus Olivier.) is a devastating insect pest of palm species in some Asian and African countries. It is reported as pernicious species for date palm in Arabian Gulf countries at mid 1980's. Since then, a lot of efforts have been exerted to control and mange this pest.

All stages of weevil development are important and earnest considerations have been practiced to hamper their augmented spread. However, larvae are the most detrimental stage of the weevil because of its gluttonously feeding habit. It worth to mention that adult female lays 200-500 eggs in the holes of wounds,

Figure 1. Red palm weevil (a) eggs (b) larva

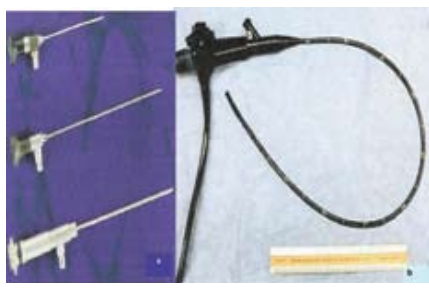

Figure 2. Endoscope, 2arigid, 2b flexible

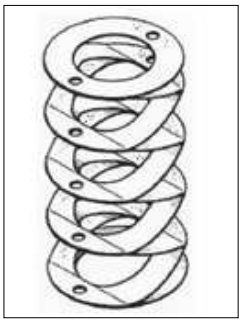

Figure 3. Ring spring containing holes for guiding cables

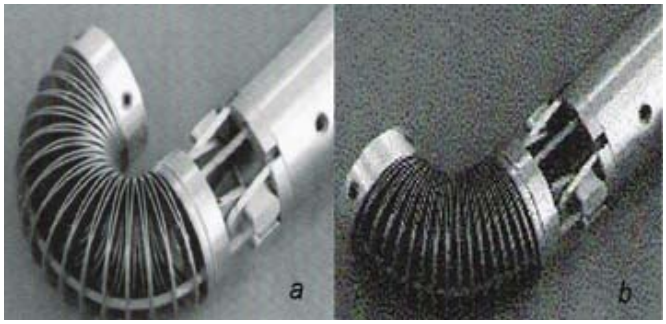

Figure 4. Rotation of endoscope tip 0 and 90º

folds of leaves or tunnels made by the weevil (Fig. 1a). The eggs hatch to whitish creamy larvae in about 3-4 days (Fig. 1b). The larvae penetrate deep in the lower part of the stem causing severe damage to the internal tissues. Severe infestation ends with eventual fall and death of the trees.

Means of control were directed towards larvae inside the trees and weevil trapping. Therefore, integrated pest management (IPM) programs were initiated in different countries. However, infestation is detected through symptom that include; presence of tunnels at leaf bases, fermented tissue dust, brown secretions and leaf yellowing. In addition, there is no confirmatory test to assess larvae control.

The objective of this manuscript is to introduce endoscopy as a new method of RPW detection and method of control confirmation.

Endoscope

An endoscope is an instrument used in either human or veterinary medicine designed specifically to look inside the body. Originally the instrument was straight, rigid affairs which had limited practical application in veterinary medicine (Fig. 2a). In the early 1970s flexible endoscopes become available (Fig. 2b).

Endoscopy is a safe, minimally invasive procedure used to evaluate the interior surfaces of an animal and/or human organ. Through the scope, it is possible to see lesions, take small biopsies and retrieve some foreign objects. The instruments vary in their length, however many practitioners have a standard three or four feet endoscope, which allows visualization of many of the common problem areas.

In case of pets having an intestinal problem, a procedure termed "endoscopy" is usually recommended. During this procedure, the pet is placed under anesthesia and a small fiberoptic camera is passed down the esophagus, into the stomach and into a portion of the small intestine (gastroduodenoscopy). With this camera it would be possible to visualize the surface of these organs and look for abnormalities. Moreover, endoscopic equipment can also be used to visualize and collect specimens from the lower respiratory tract (bronchoscopy), the nose (rhinoscopy), the urinary tract (cystoscopy) or the ear (earoscopy).

Endoscope is also used on inspection of complicated small components, such as turbine blade and cooling holes. Hence, this flexibility of the endoscope provokes the idea of using the instrument in date palm trunk tunnels and between base of leaves fetching entities of eggs and larvae. Therefore, we propose that employing endoscope in infection detection and consequent treatment of red palm weevil.

Figure 5. Endoperiscope fitted with camera

Figure 6. Earoscope

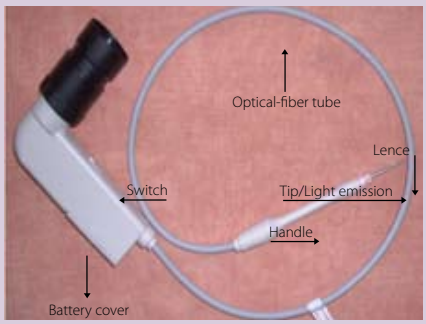

Figure 7. Parts of the Earoscope

Figure 8. Examining date palm trunk with an earoscope

Principles of endoscope

Endoscope consists of slender tubing fitted with special kind of rings known as ring springs (fig. 3). The outside of the rings is bent and the rings are welded to each other in pairs. The spring contains holes for guiding and pulling cables. By tightening one of the cables completely and releasing the other the spring is bend in a very small radius (Fig. 4a). This bend is adjustable through steering cable (fig.4b).

Fiber optic technologies are used in endoscopes. This technology allows light to be passed down a reflective coated glasses fiber to the targeted objects were then utilized. A second set of fibers with the ones carrying light allowing seeing what has been illuminated is used. In such case, using long slender instruments that are inserted through small incision in the abdominal wall carries out laparoscopic surgery. Since resilience of this instrument concedes its use for various purposes, the subtle object that probably subsist in difficult to reach places in date palm trunk and leaf bases is easily located. In fact no incision is required in case of date palm inasmuch as trunk tunnels already exist either by previous infection or the weevil itself.

For laporoscopy a steerable endoscope has been developed that known as Endoperiscope (fig. 5). This instrument is fitted with a miniature camera on the tip and steerable tip to observe object from different side. Moreover, the handgrip of the instrument contains an arrow that point always in the direction of the camera which provide intuitive control of the tip.

In this trial, a simple earosope is experimented (Fig. 6 and 7). The preliminary observations are quite credible and proved to be appeasing. This simple instrument could further developed with attachment to collect samples from the examined tunnels.

Potential benefits of endoscope

- Rapid and reliable diagnosis without dismantling
- Discover potential problems early before causing damage
- Precision optics provides a clearly focused bright image with true color transmission.
- Fully portable and easy to use

Potential use of endoscope in Red Palm Weevil

- Early detection of infection
- Precise and direct application of chemical treatment to the infectious stage
- Facilitate mechanical control via picking larvae and eggs from difficult to reach places.

Dr. Salim Al Khatri
Head of Entomology Research Laboratory
Plant Protection Research Centre,
Ministry of Agriculture and Fisheries,
Sultanate of Oman.

Date Palm Pests and Their Control.

Abstract

Date palm plantations are infested by several numbers of important pests in the Sultanate of Oman. Some of them attack fronds and some attack fruits whereas others attack the main trunk. The survey of insect pests of date palm indicated that there are more than 24 arthropod species (insects and mites) associated with date plantation. Among those dubas bug Ommatissus lybicus DeBergevin, red palm weevil (RPW) Rhynchophorus ferrugineus Olivier, lesser date moth (LDM) Batrachedra amydraula Meyer are major economically important pests affecting growth and yield of date palms quantitatively and qualitatively.

Biological studies indicated that Dubas bug has two generation per year (Spring and Autumn). Spring generation,

Nymphal stage during Spring generatin lasted for 48 days, whereas during Autumn generation stage lasted for 43 days. However, ecological studies indicated that during Autumn generation, nymphs started to appear from the 1st week of September and the peak of emergence was recorded during middle of October. Adult stage started from 2nd week of October. However, during Spring generation, nymphs started to appear from the 2nd week of February and the peak of emergence was recorded during 2nd and 4th week of March whereas adult stage started from 2nd week of April.

Ecological studies on the population dynamics of RPW showed that the minimum number of insects was recorded during December and January. However, four maximum peaks were recorded in March, May, August and October. A new trunk injection method was implemented as a control method of RPW in date palm where three holes were drilled into the palm. One hole was drilled at the oozing point, the second one 20cm above this point and the third one 20cm below it. Into each hole 50ml of the insecticide, diluted with water at the ratio of 12ml insecticide to 38ml water, was poured. This method resulted in successful treatment of RPW infestation.

Biological studies indicated that LDM had three generation. First and second generation ranged between 27 to 34 days whereas in third generation ranged between 274-313 days.

Seasonal fluctuation in the adult population of LDM showed that adult moths emerged from late February and peaks of infestation were recorded at the 2nd week of March, 2nd week of April and 2nd week of May.

Introduction:

The date palm phoenix dactylifera L. is considered a major crop grown in Gulf countries such as in the Sultanate of Oman. It is grown in the Sultanate in an area of about 35.5 thousand hectares, which occupies more than 82% of the total fruit area and about 42% of the total agricultural land. Date palm plantation reaches about 8 million palms, 64% are for fresh consumption and 36% for industrial consumption. More than 250 varieties of date palm are grown through-out the Sultanate with a production of about 281 thousand tones per year (MAF, 2002).

Date palm plantations have been suffering from number of important insect pests. Some of them attack fronds and some attack fruits whereas others attack the main trunk. The survey of insect pests of date palm conducted during 1993-1994 indicated that there are more than 24 arthropod species (insects and mites) associated with date plantation (Annual Report, 1994). Among those of major economic importance affecting growth and yield of date palms quantitatively and qualitatively are dubas bug Ommatissus lybicus DeBergevin, red palm weevil (RPW) Rhynchophorus ferrugineus Olivier, lesser date moth (LDM) Batrachedra amydraula Meyer and old world date mite Oligonychus afrasiaticus McGregor.

Dubas Bug, 0. lybicus:

It is a very serious sucking pest on date palm. Both nymphs and adults suck the sap and produce honeydew in copious amount over the leaf surface and fruits which gathers dust and leads to the growth of sooty mold. This reduces the photosynthetic activity of the leaves which results in reduction of the yield of the palm lowering of the grade of the crop and making the fruits unfit for human

consumption. Since its recording in 1962, the Ministry of Agriculture and Fisheries is concerned every year in managing the Dubas bug infestation, and that is by aerial and ground applications of selected insecticides in an area of about 12.6 thousand hectares (MAF, 1997).

Since 1980, several pesticides were evaluated for controlling dubas bug by aerial and ground applications. The recommended pesticides were Nogos 50 EC at the rate of 3.75L/Hectar, Malathion 96% ULV at the rate of 2L/Hectar, Somithion 99% ULV at the rate of 1/Hectar and Somicomdi Alfa 50% ULV at the rate of 2L/Hectar, for aerial application, and Nogos 50 EC at the rate of 200ml/100L, Decis 25 EC at the rate of 100ml/100L and Elsan 50 EC at the rate of 100ml/100L for ground application. In addition, a new method based on collecting and counting honeydew droplets produced by the insect was developed during 1989-1990. This method was established to determine the effectiveness of control measures used against dubas bug. It was effective, rapid and less hazardous and saves labour and time (Mokhtar and Al-Mjeni, 1999).

Several biological and ecological studies were conducted in the Sultanate, as from 1994 to 1996 the biological studies of dubas bug were conducted where the nymphal stages of two generations (Spring and Autumn) were determined in the field and in the laboratory. During Spring generation, nymphal stage lasted 45 - 52 days in an average of 48 days,

whereas during Autumn generation, nymphal stage lasted 37 – 47 days in an average of 43 days (Abd-Allah, et al. 1998a).

The population dynamics of Autumn and Spring generations of Dubas bug were also investigated in 1994-1996 season. The results showed that during Autumn generation, nymphs started to appear from the 1st week of September and the peak of emergence was recorded during middle of October. Adult stage started from 2nd week of October. However, during Spring generation, nymphs started to appear from the 2nd week of February and the peak of emergence was recorded during 2nd and 4th week of March whereas adult stage started from 2nd week of April (MAF, 1997).

However, several biological control agents were recorded on dubas bug such as Aprostocetus sp., Cheilomenes sexmaculata, Chrysoperla carnea and Runcinia sp. (Annual Report, 1994). Never the less, more studies are needed to determine their ability to be used in managing the infestation of Dubas bug.

The results of these studies supported the Dubas bud management programme which is based on monitoring the appearance of the pest and then determine the infestation level and then targeting the 3rd instar and the control measures should be completed before the appearance of the adult stage of the pest. The infestation level is determined by selecting 5 date palms and 3 fronds from each date palm and 20 leaflets and then counting the number of instar on the leaflets. If average number of instar on a leaflet is 5 or more, the infestation level is high, and therefore control measures should be applied (MAF, 1997).

Red Palm Weevil, R. ferrugineus:

It is a destructive pest of several palm species of economic importance whereas date palm is among them. It was first discovered in the Sultanate in the Wilaya of Mahdha in 1993 and then subsequently reported in the Governorate of Musandam and the following Wilayas: Buraimi, Shinas, Sohar, Saham and Yanqul (Abdallah and Al-Khatri, 2000).

The damage to the palm is caused by the grubs. These grubs make tunnels in the trunk and feed on the tissues of the palm. Decay of the tissues results in the production of a foul smell. While feeding, the grubs make gnawing sound which is often audible. At the point of attack, thick reddish-brown fluid is putrid and gives a strong acrid odour. At a later stage of attack, chewed up fibers are also extuded from this hole. The oozing fluid and/or the presence of these plant fibers provide external evidence of attack by the RPW (Abdallah and Al-Khatri, 2000). In very severe infestation the trunk may be hollowed out and the palm dies and topples over. Since the introduction of RPW in 1993 till 1997, 3094 date palms were infested by the pest. Among the infested trees 1604 date palm were eradicated due to heavy infestation.

As the introduction of RPW, a quarantine law was made to stop an introduction of any plant material from the plant family Palmae in the Sultanate (Al-Khatri, et al. 1998). In addition, aggregate pheromone traps were used in 1994 as a method of monitoring and controlling of RPW in order to reduce the high population. The trap consists of 10 litter plastic bucket covered with gunny and contain four halls on the lade and six holes on the side of the backed to allow the entrance of the pest. The trap contains 1 kg fermented date fruit as bait and RPW aggregate pheromone (MAF, 1995).

A new trunk injection method was implemented as a control method of RPW in date palm in 1998. In this method of application, three holes were drilled

into the palm. One hole was drilled at the oozing point, the second one 20cm above this point and the third one 20cm below it. Into each hole 50ml of the insecticide, diluted with water at the ratio of 12ml insecticide to 38ml water, was poured. This method resulted in successful treatment of RPW infestation(Abdallah and Al-Khatri, 2000).

The population dynamics of RPW was also conducted during 1996-1998 season, and the results showed that the minimum number of insects was recorded during December and January. However, four maximum peaks were recorded in March, May, August and October. The daily activity of RPW population was also studied and the highest activity was recorded during sunrise and sunset (Al-Khatri and Adallah, 2003). In addition, by 1999, a new RPW trap was introduced. The trap consists of uncovered 10 litter plastic bucket containing 1 kg fermented date fruit as bait and RPW aggregate pheromone (Adallah and Al-Khatri, 2000).

Integrated Pest Management (IPM) committee for managing RPW was formed in 1998, which was responsible to provide the necessary requirement needed to manage RPW in infested areas. In addition, the committee was responsible to monitor the implementation of IPM programme of RPW and to overcome any problem facing the programme. The programme was mainly based on monitoring the villages with infested date palms by using aggregate pheromone traps for monitoring and catching the adults, and also conducting concentrated survey at pre-maximum peaks of the pest where most of the RPW stages are larvae stage. Further-more, the programme was to control the infested date palms and eradicate the heavily infested that can not be treated, in order to reduce the pest status level and in the long run eradicate the pest in most villages. The infestation level during 1993-1997 was 3194 date palms and 50.2% of them were eradicated. However, the implementation of IPM

programme of RPW in 1998 resulted in the reduction of date palms eradicated to 23.7% eradiation out of 1843 infested date palm in 1998 and 2.6% eradication out of 953 infested date palms in 2003.

Lesser Date Moth, B. amydraula:

It is known in the Sultanate and elsewhere as Hummeira. It is a very important pest which attacks date fruits and causes several damages to dates, thus reducing the crop yield. The damage is caused by the larvae, which bore deep tunnels into the fruit, ultimately the fruit dries and drops. Infestation can be easily recognised by turning brown and remaining attached to the fruit stalks by a silken thread. Infestation may cause more than 70% loss of fruits.

Biological studies of LDM were conducted during 1994-1995 season. The results indicated that the duration of each insect stage, total life cycle and annual generation were studied under laboratory conditions. The duration of egg, larvae, pupal and adult stages of the first and second generations were 4-5, 12-17, 9-15 and 4-8 days, respectively. However, in the third generation, the egg and larval stage lasted 4-5 and 8-13 days, respectively. The results also demonstrate that the total life cycle of first and second generations ranged between 27 to 34 days whereas in third generation it ranged between 274-313 days. It was found that the pest had three generations (Abd-Allah, et al. 1998b).

Seasonal fluctuation in the adult population of LDM was studied during 1994-1995 season. Adult moths emerged from late February and peaks of infestation were recorded at the 2nd week of March, 2nd week of April and 2nd week of May. The results indicated that the infestation levels were generally significantly affected by the temperature as well as the combined effect of temperature and relative humidity (Annual Report, 1994).

Field experiments were carried out in 1994 season in order to evaluate the efficacy of some insecticides against LDM on date palm trees. The results indicated that Malation 50% EC and Kafil 10% EC at the rate of 125ml/100L of water and Diptrex 80 WP at the rate of 250g/100L of water gave more than 80% reduction in fruit infestation after 7 days of application (Annual Report, 1994).

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